TECHNOLOGY AND FORM: IRON CONSTRUCTION AND TRANSFORMATION OF ARCHITECTURAL IDEALS IN NINETEENTH CENTURY FRANCE, 1830-1889

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Abstract

This dissertation investigates the transformation of architectural ideals brought about by the development of iron construction during the nineteenth century in France. The emergence of iron construction paralleled the crisis of neoclassicism, in which an ambiguous compromise between classical formal norms and modern science and technology was already manifest in the iron reinforced lintel. In the crisis of neoclassicism, iron, with its impact on both technological and formal aspects of architecture, emerged as a symbolic material to create a new style of modern architecture among utopians and rationalists. However, iron construction could not create a new style on its own; nor did there exist absolute formal aesthetic principles to impose on the construction. This is a fundamental dilemma of modern architecture, an inherent contradiction of bourgeois culture.

Structural rationalists during the second half of the nineteenth century tried to resolve this contradiction by attempting to create a new style of architecture based on material and constructional rationality and reason. However, their inability to create a new style was finally proved in the last decade of the nineteenth century when the Art Nouveau exploitation of iron became a passion for individual fantasies, while engineers declared the triumph of their iron construction. Subsequent rationalists' change of the material signifier of architectural modernity from iron to reinforced concrete testified to the fundamental gap between technology and form, and the dilemma of bourgeois rationalism.

Early twentieth century modernist historians rediscovered nineteenth century iron construction as a precursor of modern architecture, constructing an evolutionary history of modern architecture based on the rationalist constructive tradition, from iron construction to reinforced concrete architecture. However, their "discovery" of iron construction was purely an aesthetic invention of the twentieth century based on modernist avant garde aesthetics. Behind their apparent reconciliation of modern technology and architecture lay the aestheticization of material and construction, and the subjectivization of architecture.

Thus, this dissertation analyzes the displacement of architectural discourses on iron construction from an objective construction to a subjective aesthetics. This shift characterized the further development of modern architecture and its mode of existence in modern society in relation to the development of modern technology.

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Introduction

> The theoretical knot that must be confronted is how to construct history that, after having upset and shattered the apparent compactness of the real, after having shifted the ideological barriers that hide the complexity of the strategies of domination, arrives at the heart of those strategies- arrives, that is, at their modes of production.[1]
>
> Manfredo Tafuri, The Sphere and the Labyrinth

Technology and Modernity

The experience of modernity is fundamentally related to the process of modernization of society; the major driving forces of modernization were the development of modern science and technology, and the rationalization and industrialization of production. One of the characteristics of modernity is its ambivalent attitude towards history and progress. As many theorists analyzed, in the experience of modernity, there has always been a mixture of a tendency to return to the golden past and an aspiration to a utopian future.[2] Modernity's ambiguity with regard to the progress of history was in a sense inherent in the nature of modern technology itself. As critical theorists of the Frankfurt School analyzed, while the development of modern science and technology was originally conceived as reason's grip on nature and as a liberating force for a progressive future, modern technology also subordinated the subject to technological processes. In the absence of a subject capable of controlling it, technological rationality developed as a self- propelling force, leaving an incessant dilemma as to its control and form. Reactions to this process of alienation caused by the modern technological development were presented not only as a resistance to the process of modernization but also as an investment of modern technology in an ideology. The major task of modernist cultural programs in bourgeois society was

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[1]Manfredo Tafuri, The Sphere and the Labyrinth, translated by Pellegrino d'Acierno and Robert Connolly (Cambridge: MIT Press, 1987) p. 10

[2] See Marshall Berman, The Experience of Modernity: All That Is Solid Melts into Air (New York: Simon and Schuster, 1982)

then to come to terms with the dilemmas of modern culture brought about by modern technology, which oscillated between positivism and romanticism, on the one hand, and between utopia and nostalgia, on the other. This ideological operation is particularly of interest in the study of architectural culture since, through this operation, technology entered the world of representation.

Architectural modernity, or the formation of modern architecture, was undoubtedly related to the development of modern science and technology. The processes of rationalization and mechanization of architectural production finally unshackled it from the classical system and opened a new horizon. In the aftermath of the collapse of the classical system, the mode of existence of architecture in society went through a fundamental transformation, redefining its disciplinary boundaries and the knowledge within it. Transformations of architectural ideals since the nineteenth century came in reaction to the problems and needs caused by technological changes of the modern society. A major concern of architectural discourses after the development of modern technology was how to subsume technology within the discipline of architecture, or how to reconcile it with architecture. Throughout the history of modern architecture, different positions and strategies with regard to technology have been suggested.[3] As cultural responses to the process of technologizing of modern society, one might argue that these positions themselves constitute a history of modernity in architecture.

Iron and Architectural Modernity

Among other technological developments in architecture, the use of iron as a material for architecture in particular has served as a central theme in discussions of architectural modernity since its introduction to architectural discourse in the early nineteenth century. While industrialization and mechanization of other building materials and technology such

[3] For an interesting summary of the various relationships of architecture and technology, see Stanford Anderson, "Technology and Architecture: Three Historical Lessons," Architecture: Design Implementation, Selected papers from the 9th Annual ACSA Technology Conference, ed. by Spiro N. Pollalis. pp. 28-32

as wood, terra-cotta and bricks took place as well, iron was given special attention from its inception. One of the reasons was that iron brought a completely new form with it while other materials could easily borrow their forms from received traditions. In other words, iron brought both technological and formal problems to architecture; at a technological level, iron introduced new construction techniques and new construction processes into the field of architectural production, challenging the traditional discipline. At the aesthetic level, iron brought with it a new, light structural form with slender proportions, thereby creating a tension with the traditional classical norms. While for most academic architects, iron construction was conceived as nothing but a naive technology and brute facticity, for Romantics and Rationalists alike, iron was viewed as a symbol of modernity. Particularly because of its ability to make large public spaces, iron construction was viewed by utopian architects as a promise for a technological utopia or as a new material agency to create a new modern style of architecture. In this respect, Walter Benjamin, one of the most important theorists of modern culture in the early twentieth century, gave a more sophisticated explanation for the significance of iron. In his theory of culture, Benjamin pointed out the importance of new material objects in the experience of modernity as a source of dialectic imagination.[4] Indeed, ever since their introduction to architecture, modern materials, such as iron and later reinforced concrete, have continuously served as a source of utopian imagination and were invested in the world of representation as a signifier of architectural modernity. Especially during the second half of the nineteenth century, iron, considered a symbolic material for modern architecture, emerged as a central object of architectural discussions, producing diverse discourses around it.

In the late 1920s, iron construction of the nineteenth century was taken by historians of modern architecture such as Sigfried Giedion as a precursor of the modern architecture of the twentieth century. The modernist historians viewed French nineteenth

[4] See Walter Benjamin, "Paris, the Capital of the Nineteenth Century," Reflections, ed. by Peter Demetz (New York: Schoken Books, 1986) pp. 148-149. Also see Susan Buck-Morss, The Dialectics of Seeing: Walter Benjamin and the Arcades Project (Cambridge: MIT Press, 1991)

century iron construction as a great architectural achievement; however, the aesthetic possibility of iron construction remained "subconscious" because nineteenth century architecture, only reproducing past styles, did not have adequate modern aesthetic principles to appreciate and to express it. By claiming that the subconsciousness of iron construction was finally awakened by the modern architecture of the twentieth century, they established a historical connection between nineteenth century iron construction and twentieth century reinforced concrete architecture.

The major concern of the modernist historians was to establish a formal aesthetic connection between nineteenth century iron construction and the modern architecture of the 1920s. In doing so, however, they ignored the larger socio-cultural and technological implications that iron construction brought about, and simplified the dynamic discursive field of nineteenth century architecture that had been created around this new construction. The formal aesthetics that the modernist historians appreciated in iron construction, however, had been denounced by nineteenth century architects and critics. Most of the advocates of iron construction during the nineteenth century found the reason for their support of iron construction primarily in its technological and functional aspects of it and much of their effort was spent in seeking to overcome the aesthetic weakness of iron construction.

In short, iron construction, having brought about fundamental changes in the traditional mode of architectural production and thinking as well as in the disciplinary boundaries within architecture, was also continuously invested, as a discursive object, with different meanings and places in architectural theories and histories. It could even be argued that the development of iron construction and the transformation of architectural discourses on iron since the nineteenth century literally represented the history of modernity in architecture.

In this dissertation, I will examine how iron construction was perceived in architectural discourses since its emergence in the early nineteenth century, and how and why its meaning and role within architectural discourses were transformed. More specifically, along with the actual material and technological changes, the dissertation attempts to analyze the transformation of architectural thinking, brought about by iron construction, especially that of rationalist theory of architecture during the nineteenth century, which constantly transformed itself throughout history. By doing so, I attempt to reveal the displacement of architectural discourses on iron construction from objective construction to subjective aesthetics. I believe that this is a crucial shift that occurred between the second half of the nineteenth century and the early twentieth century, characterizing the further development of modern architecture and its mode of existence in modern society in relation to the development of modern technology. Thus, while specifically dealing with architectural discourses on iron construction, the present study is ultimately a study, through the medium of iron construction, of the larger dialectics between the development of modern technology and modern architecture.

One of the ongoing dilemmas of modern architecture since the nineteenth century has been the unresolved contradiction between technology and architectural form. After the collapse of classical systems of architecture which had dominated architectural production and thinking until the eighteenth century, the creation of a new style of modern architecture became a central issue. While positivistic rationalists believed that a new architectural form would emerge through the rational use of new materials and the modern construction technology, such as iron, classicists considered iron construction as a naive technology and tried to dress it with a cultural and aesthetic form. But neither does technology produce architectural form on its own, nor do there exist absolute formal aesthetic principles to impose on technology. This was the fundamental dilemma of modern architecture, an inherent contradiction of bourgeois culture. The antinomy of technology and form could easily be extended to cover the whole debate on the fundamental contradiction between civilization and culture. Rationalists since the mid-nineteenth century have continuously tried to resolve this contradiction of technology and form. However, the inability of rationalists to create a new style was finally manifested at the end of the nineteenth century when Art Nouveau exploitation of iron became a passion for individual fantasies, and rationalists changed the material signifier of modernity from iron to reinforced concrete, while engineers declared the triumph of their iron constructions. Thus, it seems quite a logical process that modern architecture led to the formal abstraction of construction or the aestheticization of technology, and this has a close relation to the discursive formation of modern architecture towards a pure formal aesthetic discipline.

In essence, the major problems of the architectural profession that we are facing now should be understood within the same dialectics between architecture and technology, between art and science. In this respect, the received modernist rationalist interpretation of the history of modern architecture is unable to explain the fundamental problems facing modern architecture; a pretense on the part of architecture to subsume technology at the level of image has been constantly undermined by the development of a more advanced level of technology.[5] One of the goals of this dissertation is, therefore, to criticize the rationalist interpretation of the history of modern architecture based on positivism, and to investigate the dialectical processes between iron construction and architectural discourses, thereby discovering the aspects that has been ignored by the dominant theories of modern architecture.

A Critique of Rationalist Interpretation of Modern Architecture

Ever since the modernist historians' attempts to make a historical connection between nineteenth century iron construction and twentieth century modern architecture, the evolutionary relationship between the two centuries has become a norm. Without a serious study of the impact of iron construction on architecture and the transformation of architectural discourses in relation to this impact, most architectural historians accept that a

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[5] For criticisms of technological reference of modern architecture, see Reyner Banham, Theory and Design in the First Machine Age (London, 1960) and also Hal Foster, "Neo-Futurism: Architecture and Technology," AA Files14, pp. 25-27

substantial relationship exists between nineteenth century iron construction and modern architecture. They single out rationalist architects and theorists of nineteenth century iron architecture, such as Labrouste and Viollet-le-Duc, as prophets of modern architecture of the twentieth century, without explaining the substance of the prophetic quality of their architecture and theories.[6]

It seems that this now standardized interpretation of the history of modern architecture is based on what I call the positivistic rationalist narrative structure of the modernist historiography. According to this stance, the cultural crisis after the collapse of classicism was gradually resolved by the efforts of the so-called rationalist avant garde to bring the products of modern science and technology into architecture. It was through their "successive and consistent" fights against the conservative factions, the Academy and the École des Beaux-Arts, throughout the nineteenth century that the modern architecture of the twentieth century was finally achieved. In other words, the history of modern architecture was identified with the gradual "triumph of reason," where rationalist architects of the nineteenth century were regarded as the agency that brought about this achievement by integrating modern technology and architecture. In this historical process, iron, of course, was viewed as a symbolic material and the history of modern architecture was regarded almost as "the triumph of iron construction."

However, this is an overly simplistic and positivistic interpretation of more complex and dialectical historical processes.[7] The rationalist interpretation of the history of modern architecture seems to accept common myths concerning modern technology, both the myth of pure technology and that of the rational subject's control of technology. As discussed

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[6] See, for instance, Robin Middleton, "Chapter 8, Prophets of the Nineteenth Century," Neoclassical and the Nineteenth Century Architecture (New York: Rizzoli, 1987); Frances Steiner, French Iron Architecture (Ann Arbor: UMI Press, 1984) ; Alan Colquhoun, "Rationalism: A Philosophical Concept in Architecture," in Modernity and the Classical Tradition (Cambridge: MIT Press, 1991) pp. 57-87. All were based on the rationalist interpretation of modern architecture. Otherwise, historians of modern architecture started their histories in 1900 or with Art Nouveau at the turn of the century. For example, see William Curtis, Modern Architecture Since 1900 (New Jersey: Princeton Hall, 1987)

[7] Concerning the problem of modern science, see Alberto Pérez-Goméz Architecture and the Crisis of Modern Science (Cambridge: MIT Press, 1984) Pérez-Goméz clearly represents an anti-rationalist position, but his view is nostalgic.

earlier, technology is neither a pure nor a neutral process; it involves broader social processes, of which the subject's psychic condition is also a part. The positivistic rationalist interpretation of the history of modern architecture naively presupposes the existence of the rational and critical subject who is not affected by the technological processes and is able to control them.

If one considers the dialectics of modern technology and art, as well as of the subject and object, rationalist discourses in architecture do not appear to have been the same all the way through the nineteenth century; itself a part of the processes, rationalism has changed its position according to the degree to which technological processes affected architectural production. In other words, although rationalist discourses -- early nineteenth century romantic rationalists' attempts to create a new architectural style, technological discourses in architecture during the mid-nineteenth century, structural rationalist theories of architecture during the second half of the nineteenth century and twentieth century modernist theories -- developed their positions on iron construction, they were never the same, nor did they constitute a continuous and seamless developmental process towards the truimph of modern architecture. Nor do the anti-rationalist discourses of the Academy and the Ecole appear as purely conservative reactionaries. They were rational in their own way and in many cases, more consistent than the rationalists. It seems that, with all the subtleties, architectural ideals of the various factions which emerged during the nineteenth century, such as romantics, utopians, rationalists and eclecticists, in many cases make a continuum of architectural modernity.

It is true that against the simplification of nineteenth century architecture by modernist rationalist histories, many significant studies of nineteenth century Beaux-Arts architecture have been conducted since the 1970s. Contributions by Robin Middleton, Neil Levine, and David Van Zanten revealed the complexity of nineteenth century architecture.[8]

[8] See Neil Arthur Levine, Architectural Reasoning in the Age of Positivism: The Neo Grec Idea of Henri Labrouste's Bibliothèque Saint-Geneviève, (Ph.D. Dissertation, Yale Univ., 1975); David Van Zanten, Architectural Polychromy of the 1830's (New York: Garland Publishing, 1976); The Architecture of the

The studies by Levine and Van Zanten, in particular, clearly challenged Giedion's demonization of nineteenth century Beaux-Arts architecture and revealed its modern qualities. However, their studies of nineteenth century architecture are severely conditioned by the modernist historians' simplified and mystified view of it. In other words, their attempts have been made mostly in terms of architectural ideas and styles, not of an overall cultural and technological transformation of modernity. The fundamental limitation of modernist and postmodernist histories alike was their formalist view of architecture ignoring the dialectical and highly complex discursive field of cultural modernity. Thus, despite their contributions, the relationship between nineteenth century and twentieth century modern architecture remains ambiguous and the historical meanings of the major figures and theories of nineteenth century architecture have not been fully uncovered.

The history of modern architecture is a constituent of cultural modernity where various architectural ideals since the nineteenth century interacted with the new conditions of modernity. The history of nineteenth century architecture, thus, is a highly complex cultural field in which twentieth century modernism itself has its roots. Criticizing the post modern re-interpretation of nineteenth century architecture, Anthony Vidler summarized the fundamental problem well:

> It becomes increasingly clear that to accept the ideological rupture proposed by modernism itself as the instrument of its own interpretation is to deliberately obscure the circumstances of its origins and the nature of its production. If we are indeed entering a period of post modernist sensibility, then a clear understanding of modernism should be thought, one that begins to establish the ontological bases of its project rather than one that repeats the ideological polemics of its intentions. For such an understanding it is impossible to accept the clear line proposed as essential to modern architecture between realism and abstraction, between academism and the

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Ecole des Beaux-Arts, ed. by Arthur Drexler (New York: MOMA, 1977); The Ecole des Beaux-Arts, AD Profile 17 (1978); The Beaux-Arts and Nineteenth Century French Architecture, ed. by Robin Middleton (Cambridge: MIT Press, 1982)

> avant garde, between craft art and machine art, between historical styles and "style". The dissolving of these lines however implies a comprehension of the modern period as a whole, not as a field of tracing lines of influence but as a total condition of culture that, responding to the profound industrial, political, transformation of the concept of man in relation to environment.[9]

This dissertation attempts to find a historical connection between the two centuries, but in a different way from that of the modernist rationalist histories; that is, not by establishing a rationalist evolutionary relationship or by finding formal aesthetic similarities, but by tracing the origin of the current status of the architectural discipline in nineteenth century architectural development. One of the characteristics of modern architecture is, I believe, that, while modern architecture tried to embrace modern technology in order to create a new style, it ended with the increasing detachment from technological and material grounds and the emphasis on spiritual and artistic aspects of architecture. I shall attempt to investigate the origin of the mode of existence of architecture in modern society, through an analysis of the transformation of architectural discourses on iron construction. Therefore, although the dissertation is a study of nineteenth century architecture, it has a direct connection to current problems in architecture and thus, could rightly be called an attempt at a pre-history of modern architecture. In this sense, this study is both theoretical and historical; historical in the sense that it is a study of the transformation of architectural technology and ideals, theoretical in the sense that it attempts to illuminate anew problems in contemporary architectural practice.

Historiographical Backgrounds

As already implied, this study, compared to previous studies, has several methodological peculiarities, which are necessary for the above mentioned objectives. Traditionally,

[9] Anthony Vidler, "Academism and Modernism," Oppositions 8 (1977) p. 2

histories of modern architecture have focused on the development of forms and ideas, while studies of materials and construction technology have been conducted in isolation from the histories of architecture. The analysis of the relationship between the technological changes and architecture, if any, remained superficial, with the underlying belief in the normative rationalist history of modern architecture. Even historical studies on iron architecture have been limited to either the history of its technological development or new building types of iron, whose descriptive histories had only marginal relationship with architectural history per se.[10] This disciplinary boundary, however, is itself a product of modern architectural discourses. As Tafuri argued in his Theories and History of Architecture, architecture, or the act of building, originally includes a bundle of the relations of various systems affecting the construction of the human environment: technics, modes of production, economics, received formal language, typology, planning methods, law, and so on. There is also a vision of the world, a utopian hope, i.e. the intellectual labor of architects, which contradicts reality and compromises with it, realizing only its fragments.[11] Before the development of modern science and technology, these relations were superimposed on one another, and thus, architecture was always a part of a greater discourse. In its form and space, "architecture spoke everything; there was multiple stratification of meaning between the word and the thing, opacity between sign and content."[12] As modern technologies for the production of architecture developed, however, we observe a proliferation of architectural theories in which architecture became an object of linguistic analysis, whether in terms of semantics or syntax. Leaving other issues to the new disciplines such as engineering, planning and other new sciences of human environment, the objective of architectural discourse now was reduced to the

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[10] For example, see Nikolaus Pevsner, A History of Building Types (Princeton: Princeton Univ. Press, 1976); Johann Friedrich Geist, Arcades (Cambridge: MIT Press, 1985); also, Frances Steiner, French Iron Architecture (Ann Arbor: UMI Press, 1984)

[11] Tafuri, "Chapter 5. Instruments of Criticism," Theories and History of Architecture (New York: Harper & Row, 1976) pp. 171-226

[12] See Georges Teyssot, "Emil Kaufmann and Architecture of Reason: Klassizismus and Revolutionary Architecture," Oppositions 13, pp. 52-53

analysis of a pure formal system as an autonomous object of architectural inquiry with its own compactness.

What a critical historical writing should do then is to break down this disciplinary boundary. Tafuri wrote in his "Intoduction" to Modern Architecture:

> The history of contemporary architecture is inevitably multiple, multifarious even: a history of the structures that form the human environment independently of architecture itself; a history of the attempts to control and direct those structures; a history of the intellectuals who have sought to devise policies and methods for those attempts; a history of languages, which having abandoned all hope of arriving at absolute and definitive words, have striven to delimit the area of their particular contribution.
>
> Obviously the intersection of all those manifold histories will never end up in unity. The realm of history is by nature, dialectical. It is that dialectic that we have tried to pin down. . . What needs to be done, instead, is to trace the entire course of modern architecture with an eye to whatever cracks and gaps breaks up its compactness, and then to make a fresh start without, however, elevating to the status of myth either the continuity of history or those separate discontinuities.[13]

This dissertation is proposed as an attempt at an interdisciplinary study of the histories of technology, building types, and architectural ideals, among others, that have been pursued separately. Thus, while dealing with iron construction, this dissertation is not about the history of iron construction as a history of technology, but about the history of architectural thinking, ideals and ideologies. This architectural thinking, however, is not autonomous formal discourses, but in dialectical interaction with the development of new materials and construction technology. While traditional ideals have continued to exert their power, the technological processes that created iron construction also affected architectural thinking, which is a part of the process.

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[13] Manfredo Tafuri, Modern Architecture (New York: Harry N. Abrams, 1979) p. 9

In doing this, however, it should be emphasized that my intention is in no way to rewrite the history of nineteenth century architecture, or to construct an alternative history of modern architecture, but to expose various positions and tendencies, and to reveal their complexity, contradictions and gaps. Therefore, I will try not to be judgmental; instead, I will try to let history and texts themselves speak. Yet, there is still a discernible tendency in the transformation of architectural discourses. One of the themes of the Frankfurt's school's critical theory is to analyze internal contradictions of bourgeois theory and its collapse under the weight of its own contradiction.[14] As an ideology, architectural ideals also shows the same kind of internal contradiction. The self contradiction of bourgeois rationality is clearly observed in the transformation of rationalist architectural ideals. The goal of this research is thus to find and to locate the internal contradictions of bourgeois rationalism, represented in architectural thinking, discourses, and their transformation and final collapse. In this process can also be detected the discursive formation of modern architecture and of its disciplinary boundary. This study, then, as Tafuri stated, "after having upset and shattered the apparent compactness of the real, after having shifted the ideological barriers that hide the complexity of the strategies of domination, arrives at the heart of those strategies - arrives, that is, at their modes of production." [15]

The present study assumes the vital role of discourses, namely architectural theories and histories, in the formation of a concept of architecture because the institution of architecture is defined by dominant architectural theories and history. The operative role of theories and history in the modern period were pointed out by Tafuri.[16] Since this study is about collective ideals and tendencies in architectural thinking, the material for my research is limited to the published library sources, such as magazines and books, not an archival

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[14] See Susan Buck-Morss, The Origin of Negative Dialectics (New York: The Free Press, 1977) pp. 69-81
[15] Manfredo Tafuri, The Sphere and the Labyrinth (Cambridge: MIT Press, 1987) p. 10
[16] See Tafuri, "Chapter 4. Operative Criticism," Theories and History of Architecture (New York: Harper & Row, 1975)

discovery of personal statements. By the same token, the approach in this study is not biographical although I rely on biographical information about each architect and theorist.

<u>The Scope of this Study</u>

This dissertation consists of three parts, largely in chronological order. Each part corresponds to a distinctive phase in the development of architectural ideals in relation to the development of iron construction. Although the main historical period for this study is the nineteenth century, specifically between 1830 and 1889, the three chapters of Part I were included as a background, illuminating the development of iron construction and the transformation of the architectural discipline prior to this period. Chapter one analyzes the ambiguous compromise between modern technological innovation and traditional form under Neoclassicism, which was symbolically represented in the iron reinforced lintel. Chapter two discusses the emergence of iron construction in relation to the collapse of Neoclassicism, rather than as a result of the technological development of iron. The ambiguous compromise of reinforced lintels under neoclassicism and subsequent emergence of iron construction with the crisis of neoclassicism prefigured the fundamental dilemma of rationalism between technology and form. Chapter three deals with the various attempts to reorganize the neoclassical paradigm in the development of modern technology, and the ultimate separation of the neoclassical theory of architecture into the art of design and the science of building.

The six chapters in Parts II and III basically deal with the dialectic interactions between iron construction and architectural ideals after its emergence, between 1830 and 1889. Part II discusses the historical process of the emergence of iron as an agency for the creation of a new modern style. Chapter four analyzes the emergence of iron construction and its impact on architectural ideals, especially on utopian ideals and architectural theories. It was on two levels that architectural theory changed: first, the attempt to change the architectural discipline to a more scientific one and second, the romantic rationalist movement within the Ecole. Chapter five discusses the relationship between iron and rationalist ideals for an architectural renewal in the mid-1830s. Although the new rationalist theories of architecture tried to create a new architecture of the nineteenth century, relying on the historical research of the transformation of structural principles and modern technology, iron was not yet a concern except for a few architects such as Labrouste and Reynaud. It was after 1846 that iron finally emerged as a material for a new style. Chapter six discusses how iron entered the rationalist architectural discourses for the creation of a new modern style.

Three chapters in Part III show the dilemma and contradiction of rationalist architectural theories and their inability to create a new style. Chapter seven discusses structural rationalist ideas that attempted to create a new architectural style of the modern age through a rational use of iron, and their fundamental dilemma in the separation of art and industry during the Second Empire. Chapter eight discusses the emergence of iron construction as a symbol of modern architecture during the Third Republic and the paradoxical transformation of the rationalist theory of architecture from construction to aesthetics of the material, and its ultimate choice between aesthetics and engineering. Chapter nine analyzes the demise of iron as a material for modern architecture after Art Nouveau and the subsequent change of material signifier for modern architecture to reinforced concrete.

Finally, in the conclusion, I will discuss the misrepresentation and the aesthetic invention of nineteenth century iron construction by modernist histories of the early twentieth century and their ideological dimension.

Part I

Iron construction and Neoclassicism, -1830

Chapter One: Iron Reinforced Lintel: A Paradox of Neoclassical Architecture, 1670-1800

> .... it seems that modern architects have considered the use of voussoirs in the construction of flat vault and architrave as one of these victories over nature. In this respect, they have perhaps misled themselves to a too large extent, and too early; they may also have used these means too ostentatiously, which from now on, represent a faint equivalent to the resources that nature has refused to certain countries.
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> Quatremère de Quincy, "Claveau," Dictionnaire Historique d'Architecture, Paris, 1832

Iron has been used as a building material since ancient time: In the Greek period, iron was used in masonry walls and columns as dowels to guard against the horizontal movement of the stone; during the Roman period, iron continued to be used for dowels and cramps in masonry structure although concrete and the arch were mainstays of these builders; in Gothic construction, iron was employed as anchors, tie rods or cramps; since iron tie rods were essential to resist the outward thrust imposed on a wall by vault or dome, iron continued to be used during the sixteenth and seventeenth centuries in the domes of major buildings such as the churches of St. Peter in Rome and St. Paul in London.[17] In all these cases, iron was used as a secondary aid to the major structural material.

However, in the late seventeenth century, iron armature began to be used in a more systematic way as a reinforcing material in French neoclassical architecture; iron reinforcement of lintels with flat voussoirs was used in such an extensive and complicated way that iron reinforcement itself became a major structural element even though it was hidden behind the classical facades. As Joseph Rykwert writes, "the structure virtually became a reinforced masonry construction, analogous to reinforced concrete."[18] The iron

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[17] For the earlier use of iron in architecture, see Cecil D. Elliott, Technics and Architecture (Cambridge, Mass: MIT Press, 1992) Chap. 4 and also Wilicox, R., Timber and Iron Reinforcement in Early Buildings (London: Society of Antiquaries, 1981)

[18] Joseph Rykwert, The First Moderns (Cambridge, Mass.: MIT Press, 1980) P. 89

reinforced lintels with flat voussoirs were a completely new experiment, never used by ancient builders.

Iron reinforced lintels and columns were first used in Claude Perrault's east colonnade of the Louvre which was built between 1667 and 1671. The project of reconstruction of the major part of the Louvre was intended by all means to possess "grandeur" and "magnificence," a monument of Classicism to symbolize the newly centralized political and economic power of Louis XIV, "the Sun King."[19] When Jean-Baptiste Colbert became the king's new Finance Minister and the General Inspector in 1664, the east wing of the Louvre, designed in 1661 by Louis Le Vau, the *premier architecte du roi*, was already under construction. However, dissatisfied with Le Vau's design, Colbert asked Parisian architects to submit alternative designs.[20] The re-design process initiated by Colbert continued for three years, and involved the Italian master, Bernini although his design was ultimately rejected.[21] In 1667, a committee of Claude Perrault, Louis Le Vau and Charles Le Brun was formed to produce a final design. In the same year, the King finally approved one of their proposals. The final design for the east facade of the Louvre approved by the King, was a peristyle of coupled columns with an unbroken entablature after the model of ancient architecture.(fig. 1, 2) Although there are

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[19] There was certainly a political symbolism in the idea of the colonnade. Nan Myra Rosenfeld wrote: "Louis XIV was often represented in the guise of Apollo, the Sun God, . . and Le Brun depicted the place of Apollo as a colonnade." in "The Royal Building Administration in France from Charles V to Louis XIV," in The Architect: Chapters in the History of Profession, ed. by Kostof, (New York and Oxford: Oxford University Press, 1977) p.176. Colbert told the king Louis X IV about the role of classcical architecture in the expression of the gloification of the French state a few years before the founding of the Academy: "Your Majesty knows that, except for the outstanding militatry engagments, nothing marks the gandeur and sprit of princes more than buildings, all posterity measures these quailities by the merit of the splendid houses that they have raised during their lives." (Sep. 1668) Hautecœur, Histoire de l'architecture classique en France, vol II, p. 264. translated and quoted and in Donald Drew Egbert, The Beaux-Arts Tradition in French Architecture (Princeton: Princeton Univ. Press, 1978) p.111

[20] Colbert's dissatisfaction with Le Vau's design was in part due to his personal experience. However, Charles Perrault wrote in his Mémoires that Colbert's dissatisfaction was due to a design problem. "Monsieur Colbert was not happy with this design,... It is capital importance that the palace be given a facade worthy of the prince who was having it built." Charles Perrault, Mémoires English translation by Jeanne Morgan Zarucchi, P. 54

[21] It was in part by the intrigue of French bureaucrats and in part by his inability to meet the requirement of embracing the existing structure that Bernini's design was rejected. For a detailed discussion, see Joseph Rykwert, op. cit.

many questions unresolved about the authorship of the Louvre colonnades, it is certain that Claude Perrault played a major role in designing and determining the proportion of the colonnades as well as in executing the project.[22]

The construction of the east facade of the Louvre involved many technical difficulties due to its large scale. The intercolumnation and depth of the peristyle were much larger than a normal ancient model.[23] According to Charles Perrault, a secretary to Colbert and brother of Claude Perrault, the other members of the design committee, Le Vau and Le Brun had been hesitant to approve the design of peristyle. They held doubts on the execution of the building because of its large scale.[24] Moreover, massive stone for lintels of such a large scale was not available in France; nor was the stone found in France as strong as the marble used in Greek temples. Thus, the huge lintels had to be constructed with small pieces of stone called *voussoirs* (*claveaux* in the contemporary terms) as was common in arches. In order to create the lintels with *voussoirs*, Perrault systematically reinforced the construction with iron bars: a metal bar was placed in the center of each column to ensure coherence and to anchor the two bars that were threaded through the upper part of the front entablature and linked back through a further system of bars set in the beams, to the wall behind. Each bay was further stabilized by two cross bars forming an X the voussoirs of the front entablature were linked to one another with independent Z bars.[25] (fig. 3)

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[22] Charles Perrault argued that the design was originally his (see his Mémoires). But Boileau contested Perrault's claim, arguing that the deign was Le Vau and Francois d'Orbay's (see Nan Myra Rosenfeld, "The Royal Building Administration in France from Charles V to Louis XIV," in The Architect) Some argue that the idea of colonnade was Le Brunc's despite the Charles Perrault's claim that he and his brother Claude were responsible for the idea (see Robert W. Berger, "Charles Le Brun and the Louvre Colonnade," in Art Bulletin, no. 52 (Dec., 1970) pp. 394-403

[23], The span became even larger after the 1668 change that doubled the south wing of the Louvre. See Antoine Picon, Claude Perrault, 1613-1688 ou La Curiosité d'un Classique (Paris: Picard Éditeur, 1988) p. 184.

[24]Charles Perrault wrote: "It is true that Monsieur Le Vau and Monsieur Le Brun, were incapable of approving my brother's design, saying always that it was only beautiful on paper, and undoubtedly its execution would be difficult because of the excess of depth of the peristyle, which was twelve feet, and the architraves, which projected into the air, would topple the whole structure." Mémoires, English translation by Jeanne Morgan Zarucchi, P. 54.

[25] For the complete description of the reinforcement of the colonnade, see Pierre Patte, Mémoires sur les objects les plus importants de l'architecture (Paris, 1769) pp. 269-277.

Perrault's systematic use of iron armature for the reinforcement of a flat-arched lintel clearly reflects the modern scientific and analytical thinking that had developed since the early seventeenth century. During the first half of the seventeenth century, dramatic advances were made in modern science by thinkers such as Francis Bacon, Rene Decartes and Galileo.[26] Their new scientific paradigms subverted the traditional world view which was based on a priori knowledge prescribed by a divine revelation, and opened a new horizon for the development of new empirical modern sciences which were based on scientific observation and the analysis of natural phenomena.

The archaic system of thinking was based on the belief that a structure of microcosm is a reflection of the structure of macrocosm, which is ultimately governed by the divine idea in nature. Since the divine idea was represented by number or geometry in the archaic system, it was believed that there were perfect Forms with harmony derived from the divine rule; the form of a design product should then be an embodiment of the divine idea. Classicism in architecture was certainly based on this archaic system of belief. The essences of classical architecture were proportions and orders which had been explained by Vitruvius in his Ten Books on Architecture. According to this Roman author, the proportions of the orders were derived from human proportions. This anthropomorphic analogy was given a further divine justification during the sixteenth and seventeenth century, by authors such as René Ouvrard: Since men were created in the image of God, he argued, the proportions of the classical orders whose origin was the human proportion, should also be considered a perfect form created by God.[27]

The archaic system, which Michael Foucault termed "a system of resemblance" in his Order of Things, was overturned by the development of modern science and the mechanization of architecture.[28] In his article, "The Mechanization of Architecture and the

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[26] See Pérez Gomez, Architecture and the Crisis of Modern Science, (Cambridge, Mass: MIT Press) 1983, Chapter 1.
[27] René Ouvrard, Architecture harmonique (Paris: 1677) For a detailed explanation, See Rykwert, op. cit., Chapter 1.
[28] Michel Foucault, The Order of Things (New York: Vintage Books, 1973)

Birth of Functionalism," Alexander Tzonis summarized the essence of this scientific revolution that occurred in the first half of the seventeenth century as a paradigm shift from "the primacy of Idea over Matter" to the reverse.[29] According to Tzonis, the break with "the system of resemblance" of the Renaissance world was most clearly demonstrated in Galileo's book, Dialogues Concerning Two New Sciences, published in 1638. In this book, Galileo found it remarkable that Venetian technicians used "... stocks, scaffolding and bracing of larger dimension for launching a big vessel than they [did] for a small one... in order to avoid the danger of the ship parting under its own weight..."[30] Tzonis wrote:

> He[Galileo] saw it as putting into question the archaic doctrine of the primacy of Idea over Matter, which held that if a large object is constructed in such a way that its parts bears to one another the same ratio as in a smaller one, and if the smaller is sufficiently strong for the purpose for which it is designed, then the larger also should be able to withstand any severe and destructive tests to which it may be subjected.[31]

Tzonis elaborated on Galileo's observation on the proportion of machines: "If a large machine is built of the same material and in the same proportion as a smaller one, then the larger one will not be so strong or resistant against violent treatment. Proportions and form alone could not keep it from breaking."[32] (fig. 4)

What was significant in Galilean mechanics was that proportions were no longer governed by perfect "Forms" of the world or by the divine "Idea". It was seen, rather, as "something bound to matter that changes according to the size and material of an object."[33] The form of a product was now to be determined by its material property and its size rather than by the divine Idea. "The initial observations made by Galileo on machines," as Tzonis

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29 Alexander Tzonis, "The Mechanization of Architecture and the Birth of Functionalism," VIA 7 (1976)
30 Ibid., p. 130
31 Ibid., p. 129
32 Ibid., p. 130
33 Ibid., p. 129

argued, "are then transferred to construction elements such as pillars, cantilevers and architrave. Thus, gradually the complete building fabric was seen in analogy with the machine. Its form does not follow the Idea; instead it was determined by the behavior of matter."[34]

During the last third of the seventeenth century, the implication of Galileo's new scientific paradigm was generally accepted by philosophers and scientists.[35] Claude Perrault, as an anatomist and a member of the Academy of Science, which was established in 1666 by Colbert with a view to promote all sciences, had thorough knowledge of Galilean science. He even carried out an experiment to confirm a result of Galilean science. It is clear, therefore, that in systematically reinforcing the colonnades of the Louvre with iron armatures, Perrault broke with the transcendental paradigm of Classicism and adopted the modern analytical understanding of structure established by Galilean science. As Galilean mechanics suggested, if one wished to build a large scale structure with the same proportion as a smaller one, the large building would not have sustained its own loads. In order to construct the large structure, one should then improve the natural limit of the material resistance by systematically reinforcing it. Perrault was a specialist in the construction of machines and even had applied the model of a machine to the human body in the physiological studies in his Essais de physique, published in 1680. Of this relationship between the colonnades and the anatomic studies, Antoine Picon writes:

> Il semble bien que sa passion de l'anatomie ait trouvé à se satisfaire d'un mode de construction fonctionnant sur l'opposition entre squelette et membrure. La compression que le métal fait subir à la pierre rappelle également la conception du corps comme une structure tendue qu'expose l'académicien dans ses *Essais de physique*. Au ressort naturel des muscles

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[34] Ibid., p. 130
[35] See Pérez Gómez, op. cit., p. 18

répond d'une certaine façon le ressort artificiel que les tirants confèrent aux linteaux de la colonnade.[36]

In Perrault's use of iron reinforcement for the Louvre colonnades, however, there was an apparent contradiction. In his new science, Galileo had introduced the notion of the limit, or an absolute resistance. He wrote: "...for every machine and structure, whether artificial or natural, there is a necessary limit beyond which neither art nor nature can pass. . . You can plainly see the impossibility of increasing the size of structure to vast dimensions either in art or in nature; likewise the impossibility of building ships, palaces or temples of enormous size in such a way that their oars, yards, beams, iron-bolts, and in short, all their other parts will hold together."[37] The Galilean notion of limit sets a new norm to the proportion of a structure, and thus to the definition of proportion and beauty. Perrault's iron reinforcement of the large scale of a classical facade was then clearly violating the new norm set by Galilean science. In other words, Perrault used the modern analytical concepts of structure and techniques of construction only to preserve the traditional aesthetic norms of Classicism. Fully recognizing this problem, Perrault distinguished the proportion of architecture from those proportions required in military architecture and machine. While the dimension of machine and military architecture were to be determined exactly by the material strength and mechanics, he argued, architectural proportion was not.[38]

Despite the maintenance of classical orders and proportions, the colonnades of the Louvre, had many modern features that broke with the ideal of classical architecture. These features caused debates between Perrault and classcial architects such as François Blondel.

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[36] Ibid., p. 184: " ...his passion and knowledge in anatomy was satisfied with the mode of construction functioning on the opposition between skeleton and membrane. The compression that metal subjects to stone in iron reinforcement recalls equally the conception of body as a strained structure which Perrault exposed in his Essais de physique ...."
[37] Alexander Tzonis, op. cit.,
[38] See Claude Perrault, Ordonnance des cinq éspèces des colonnes, selon la méthode des anciens (Paris, 1684)

The debates around the colonnades resembled in many ways the quarrel between the Ancients and the Moderns, which occurred in the late seventeenth century, on the "authority of the Ancients" and on the concept of "progress."

Classicism was based on the firm belief that architecture of ancient Greece and Rome was the only true architecture derived from the authority of nature. In classical architecture, proper dimensioning of architectural elements based on the absolute proportion guaranteed not only perfect beauty but also the solidity of construction. The resort to metal then clearly contradicted the classical notion of the solidity of a structure. Since iron reinforcement distorted the visual appearance of solidity, Perrault was criticized by his contemporaries and he had to defend his position several times.[39] He even made a reduced wooden model of the peristyle with iron bars to allay the suspicions about the solidity of the structure.[40]

His design of the coupled column also represented the modern scientific thinking of structure and the impossibility of imitating the ancient model. As the notion of limit had been introduced by Galileo, it was well known by that time that if a structure became larger it was more efficient to support it with many structural elements of smaller dimension rather than simply increasing the dimension of the element. Perrault's invention of the coupled column, in this sense, was to give a structural stability to the colonnades while maintaining the proportions of structural elements. François Blondel, a mathematician and the director of the Academy of Architecture which was established in 1671, criticized this "modern feature of Perrault's colonnades" in his Cours d'architecture, published between 1675 and 1683. Using his mathematical knowledge, Blondel interpreted that contrary to the claim of Perrault, the coupled column was mechanically unsound and it would not reinforce the cantilever of the architrave. Blondel believed in the absoluteness of beauty and the natural origin of proportion, and his concept of stability of construction still had the character of

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[39] Antoine Picon, op. cit., p.184
[40] Charles Perrault, Mémoires, p. 82.

divine revelation. Although Blondel was a prominent mathematician and knew the scientific progress of his time, he failed to distinguish between proportional rules and mathematical laws of mechanics, between proportion of aesthetic consideration and technical concerns. Blondel's criticism of the coupled column was, thus, based on the fact that it violated the simplicity and natural form to which architecture must conform and, above all, it had no historical precedent.[41]

Against Blondel's criticism, Perrault defended himself at length in his commentary to Vitruvius' Ten Books on Architecture, published in 1684. Perrault's main point of argument was the freedom of invention of individual architects as opposed to the necessary imitation of antiquity. He wrote, "la principale objection sur laquelle on s'appuye le plus est fondée sur un préjugé et sur la fausse supposition qu'il n'est pas permis de se départir des usages des anciens."[42] In fact, applying modern scientific paradigm of Decartes and Galileo to architecture, Perrault had already developed a rational theory of architecture which removed architecture from the transcendental network that linked it with the divine rules in the archaic world. In the preface of his illustrated edition of Vitruvius' Ten Books on Architecture, published in 1674 at the request of Colbert, Perrault denied the correspondence between architectural proportion and musical harmony which had been taken for granted by classical architects and theorists. He asserted that unlike the harmony in music, there was no rule for beauty given a priori to please our sight in architectural proportion. If the proportion of the orders of ancient buildings had been absolute, he argued, the discrepancy between the proportions in theory and those in real buildings would have been inexplicable. Thus, rejecting the absolute authority of the Ancients, he claimed that it was possible to make a "beautiful invention."

In the preface to the Ordonnance des cinq éspèce de colonnes which Perrault published in 1683 with the intention to make an appendix to Vitruvius' book, he went on to

[41] Joseph Rykwert, op. cit., p. 84, originally in F. Blondel, Cours d'architecture (1698) pp. 228-235

[42] Vitruvius, Les dix livres d'architecture de Vitruve, trans. Claude Perrault (Paris, 1673); 2nd ed., revised and enlarged in 1684, 78-79, n.16: "Blondel's main objection . . . is found on a prejudice and on the false supposition that it is not possible to abandon the habits of ancient architects."

argue that the rules of the proportion of the orders was not derived from human proportion, nor from nature, but are a customary and arbitrary habit. Therefore, proportion does not guarantee the beauty of architecture; it was like a fashion which changes depending on the society and the custom. He then distinguished this arbitrary beauty from a positive beauty which was derived from nature and which directly appeals to our senses; grandeur, magnificence, the richness of building material and the exactness and propriety of execution and a general symmetry of disposition were the aspects of the positive beauty that Perrault defined. Since positive beauty was by definition what is obvious to everyone, there is nothing in particular that architects can do about it. Therefore, according to Perrault, what mattered in architecture is to set up the rule of arbitrary beauty, which is taste. Taste is then to be justified by society, which is the role of an institution. Beauty of architecture, thus, became like a language defined by a social institution. Consequently, in Perrault's rational theory of architecture, a complete separation between taste and construction, between invisible conception and visible perception was made, and beauty was determined in terms of visible aspects, rather than invisible harmonious causes. Once architectural proportion was freed from the transcendental network and became an arbitrary system as Perrault argued, the transcendental justification of stability of the construction was also rejected and its construction could be innovated beyond the dimension given by the natural limit.

However, Perrault's rational theory of architecture had an ambiguity between freedom of invention and absolute necessity, which constitutes the core of the problems in modern architecture up until now. By arguing that there is no absolute proportion of the orders, derived from nature, Perrault provided freedom for the invention of taste. At the same time, however, he never questioned the validity of the classical orders and even frequently used the ancient authority to justify his theory. In other words, while rejecting the idea that numerical systems of classical orders are the invisible and universal cause of beauty, Perrault nevertheless accepted the norms of classical architecture without reservation. In a sense, the iron reinforced colonnades of the Louvre symbolically represented the ambiguous nature of Perrault's rational theory of architecture: The most sophisticated procedures of construction and technical innovations, based on modern science and technology, were mobilized for the simplicity of ancient style.[43] The openness of Perrault's system, that is, the possibility of the invention of taste by individual architects, however, might lead ultimately to a tabula rasa, as Decartes had criticized Galilean science.[44] In fact, Perrault feared the tendency of subjectivism, and this was why he tried to justify the classical orders through social convention.[45] However, when Classicism finally collapsed, the problem of form and style became as a central issue.

The tension between freedom of invention and absolute necessity which existed in Perrault's rational theory of architecture remained basically unresolved until the eighteenth century. As a matter of fact, between 1680 and 1735, the incipient subjectivism of Perrault, which questioned the absolute rules of classical architecture, strongly affected design. With the proliferation of pattern books, there emerged a tendency of tabula rasa in architectural design, called Rococo.[46] (fig. 5) In order to maintain the norms of Classicism, thus, eighteenth century architectural theory had to come to terms with the problem of freedom of taste by basing it on more positive ground, rather than on arbitrary

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[43] While this rational thinking and technical advances clearly went beyond the limit of the classical paradigm of architectural production, the norms of classical antiquity were maintained.

[44] Joseph Rykwert analysed that there an obvious affinity between Perrault and Decartes in "[their] analysis of commonly held opinions and in an attempted synthesis by deduction from the primary intuitions to which the idea have been stripped. However Perrault's methode was closer to the Galiliean. In fact, Decartes had criticized Galilo because of the possibility of the subjectivism in Galileo's method. See Joseph Rykwert, op. cit., p. 42

[45] In this sense, the real difference between Perrault and Blondel was not so serious as later critics of neoclassicism believed. Only difference was the way architectural beauty of classical antiquity was secured, whether relying on the authority of nature or on that of society. The fact was that Perrault was only more radical than Blondel.

[46] Although the style known as "Rococo" was largely confined to decoration, the freedom of invention finally went against the norms of classical architecture as could be seen in the design of the church of Saint Sulpice by Meissonnier in 1726. See Joseph Rykwert, op. cit., Chapter 5, "The Pleasures of Freedom," pp. 96-117.

custom. This was the problem that eighteenth century Enlightenment architects and engineers had to work out.

The dilemma of neoclassicism was apparently resolved by structural theories of architecture which tried to explain the beauty of proportion through constructional principles which are positive. These structural theories, by arguing for a proper visual expression of a structural rationality, attempted to make a framework where the mechanization of construction and aesthetics would be compatible. This might be properly called the first "functionalist" attempt to unite aesthetics and construction since Perrault's distinction between taste and construction.

Engineers and architects such as Félibien and Fremin had already developed this line of thought by the late seventeenth century. It continued in the writings of Cordemoy and Frezier in the early eighteenth century. Although there were differences among them, they had a common interest in construction and the technical problems of architecture, rather than in the classical norms of the orders and proportions alone. They believed that the true principles of architecture should be derived from the principles of construction. As early as 1699, J.-F. Félibien in his Dissertation touchant l'architecture antique et l'architecture gothique wrote that "it is not enough that a building be constructed solidly, it must appear so to the eyes." In 1702, Fremin, in his Mémoires critiques d'architecture, questioned the primacy of the classical orders and proportions and stated that buildings had to signify their construction. In his Dissertation sur les ordres d'architecture (1738) Amédée-François Frézier also argued that the classical order should be subjected to rational laws, which could guide architecture towards pure natural beauty based on construction. Frezier's theory of architecture especially sought to recover the traditional interest in the absolute value while accepting the increasing power of reason without contradictions.

Common to all the structural theorists was the study and admiration of Gothic architecture as a model of structural rationality. They then tried to revive what they believed to be a pure classical architecture by relying on the model of Gothic architecture.

To revive Classicism based on the structural rationality of the Gothic model became a unique characteristic of the eighteenth century French Neoclassicism. As far as the appreciation of Gothic construction is concerned, of course, Perrault was considered a precursor. In his Ordonnances, Perrault mentioned the quality of *dégagement* in Gothic architecture, meaning that each element retained an air of independence while maintaining the unity of the whole.

An early eighteenth century architectural theorist who most successfully provided a model for French Neoclassicism which united the rational interpretation of the Gothic and the honest structure of Classicism was Abbé de Cordemoy. In his Nouveau traité de toute l'architecture, published in 1706, Cordemoy argued that ancient Greek architecture was more pure than the Renaissance had cared to admit. He argued that ancient Greek architecture had a quality of *dégagement* like Gothic construction and that both successfully expressed the function they were to perform. Cordemoy then proposed a model of an ideal church with freestanding columns and lintels. The neoclassical church with free standing columns was conceived of as the unity of Gothic structural rationality and the classical ideal of purity, as the unity of Gothic lightness and Greek simplicity, and became a unique characteristic of eighteenth century French neoclassical church.[47]

The most influential theory of rational neoclassical architecture during the mid eighteenth century was developed by Abbé Laugier. In his Essai sur l'architecture published in 1753, Laugier suggested an architectural model of a primitive hut, taking up the criteria of Cordemoy. Laugier's model of the primitive hut consisted of free standing columns, an unbroken entablature and a triangular pediment. He justified the primitive hut, by returning to the origin of architecture in natural state.(fig. 6) That is, the elements, in his model, were essential constructional elements in the primitive state of building industry and all other unnecessary ornaments disappeared. In the contemporary tendency of the

[47] See Robin Middleton, "The Abbé de Cordemoy and the Greco-Gothic Ideal," Journal of Warburg and Courtauld Institutes, vol. 25, nos. 3-4, (1962) 63.

relativization of styles, the return to the origin of architecture and the primitive model based on the first product of human industry in nature, became a powerful doctrine of neoclassicism, and Laugier's hut was considered the true realization of the Greek ideal of simplicity.

In Laugier's theory, the essential relationship between architecture and nature, which was rejected by Perrault's theory, was firmly reestablished. If nature no longer presented the absolute proportion of the orders of classical architecture, it provided instead a "type" as the origin of architecture, where fundamental parts of classical orders corresponded with the very structure of the building.[48] Thus, the beauty of architecture, or the true principles of architecture was again dependent on absolute nature not arbitrary custom. Laugier's hut then became an imitation of the natural form, where taste and construction were reconciled. But unlike the archaic classical paradigm, the cause of beauty should be visible and be identified with rational, rather than invisible, hermetic or speculative rules.

Laugier's rational theory of architecture was influenced by the concept of nature as revealed by the new empirical sciences of the Enlightenment. Newtonian science of the mid-eighteenth century transformed the notion of harmony in nature from an invisible hermetic one to concrete mathematical rules which are visible and observable. The rules of proportion were no longer the representation of the hermetic harmony of nature, but were derived from reason and concrete to the spectator's eyes. Reason, or the mathematical rules behind the natural phenomena that modern science discovered, was then interpreted as a medium linking the divine force and nature. In this way, the absolute value of the classical norms of the orders and proportions was transferred to, and consolidated by, reason and mathematical laws in nature.[49] After 1750, thus, numerical proportions

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[48]See Anthony Vidler, "The Idea of Type," Oppositions 8 (1977) pp. 95-133

[49] Alan Colquhoun wrote,"Just as the task of the painter or sculptor...is to imitate the idea lying behind the imperfect appearance of nature, so it was the task of the architect to uncover the types lying concealed in the manifold, but imperfect, examples presented by the history of architecture, Architecture was treated exactly as if it were the natural phenomenon," "Rationalism: A Philosophical Concept of in Architecture," in Modernity and the Classical Tradition (Cambridge, Mass: MIT Press, 1991) p. 61

recovered their traditional symbolic role in architectural theory. It is not surprising then that most Enlightenment architects and engineers rejected Perrault's radical theory of arbitrary beauty of proportions in favor of Blondel's more conservative one which believed in the perfect proportions derived from nature.

During the first half of the eighteenth century, Cordemoy's idea of the ideal church with freestanding columns was taken up by Germain Boffrand (1667-1754), whose master Mansart had already worked out this idea in the royal chapel at Versailles (1689). Boffrand's chapels at the Chateau at Lunéville (1719), St. Jean-en-Gréve in Paris (1735) and St. Francois-de-Paul at Toulon (1744) were erected with freestanding columns carrying lintels.[50] (fig. 7) But these lintels were built of timber beams encased in plaster, not of stone. Not until the second half of the eighteenth century did architects develop the ability and confidence to work out the entire scheme in stone on the line suggested by Cordemoy.[51]

A tendency to return to the classical against the taste for Rococo became strong especially after 1735. Starting with the west front of the church of Saint Sulpice designed by J. N. Servandoni (1732-1777), neoclassical architecture with free standing columns and lintels--Gabriel's Palace of Louis IV (1755-63), Constant d'Ivry's church of St. Vaanon at Lond sur Escont (1751) and the church of the Madeleine (1763)-- began to be designed and built. Jacque-Germain Soufflot completed the facade of Ste.-Sulpice in 1749 and began the church of Ste.- Géneviève in 1757, which was conceived by Laugier as a perfect model of the neoclassical church.[52] (fig. 8, 9) All these churches were constructed with free standing columns and lintels which were built entirely with stone. In realizing freestanding columns and lintels with stone, however, it was not possible to use monolithic lintels after the fashion of the Ancients. Due to the absence of large stones in France, the lintels had to

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[50] See Robin Middleton, op. cit.
[51] Ibid., p. 309
[52] For the detail of these churches, see Robin Middleton, "The Abbé de Cordemoy and the Greco-Gothic Ideal, part II," Journal of Warburg and Courtauld Institutes, vol. 25, nos. 3-4 (1962)

be built with voussoirs and iron reinforcements. It is without question that Perrault's colonnade of the Louvre served as a paradigmatic model for these constructions.

The technique of iron reinforced column and lintel culminated in Soufflot's church of Ste-Geneviève, which was built between 1755 and 1790. The porch of the church of Ste.-Geneviève was worked out by Jean-Baptiste Rondelet, the chief inspector of the church. In 1770, when Rondelet was charged by Soufflot to work out the details of the entablature, he hollowed out the entablature to alleviate the pressure on the flat arches of the architrave with relieving arches. Rondelet designed each plate-band with flat aches with thirteen voussoirs, above which he built another relieving arch of thirteen voussoirs. A stone above each capital served as the springer of the flat arches as well as for the relieving arch. In order to secure the stone voussoirs in their places, Rondelet designed a sophisticated system of iron reinforcement.[53] (fig. 10) Soufflot's church of Ste.-Geneviève marks the final point of the evolution which had started with the Louvre a century before, which explored to an extreme the fragile compromise between an architectural model and the technique of realization, as I will discuss later.

In the iron reinforcement of the lintels and columns of the eighteenth century neoclassical architecture, however, there was an apparent contradiction. Unlike Perrault's radical separation between taste and construction, eighteenth century neoclassical theory reconciled taste and technical rationality by endowing the classical norms and proportions with the mathematical laws of nature. It seems self-contradictory then that the radical coherence between technical and aesthetic dimensions that neoclassicism had as its ideal could only be achieved in reality at the expense of what François Viel later called "indirect forces", which only complex metallic armature could afford. Resorting to a most unnatural

[53] For the detailed description of the iron reinforcement, see Frances Steiner, French Iron Architecture, (Ann Arbor, Michigan: UMI Press, 1984) p. 22 and Jean Baptist Rondelet, Traité théorique et practique de l'art de bâtir (Paris, 1802-17) After a crack was discovered in the piers supporting the dome in 1780, Rondelet reinforced the piers with about 60 centimeter thick masonry structure. In linking the supplementary masonry to the piers, Rondelet used wrought iron triangulation. Rondelet's use of iron prefigured reinforced concrete in that iron was intimately related to masonry, absorbing the force of traction. See Bertrand Lemoine, L'architecture du fer (Champ Vallon, 1986) p. 32-34

technique of iron reinforcement certainly distorted the natural law of forces that the structure gives to the spectators' eyes. The idea of the rational neoclassical church--the unity of Gothic lightness and magnificence of Greek architecture--was, thus, a very contradictory and ambiguous compromise between the architectural model and structural rationality.

However, the discrepancy between the rational model of architecture and the technique of realization was not considered a problem to eighteenth century neoclassical minds because during the eighteenth century, the rationality of structure was always measured within the limit of the formal norms of classical architecture. The rationality of structure, for the eighteenth century rationalists, was achieved by the perfect legibility of space, contrasts between wall and column and articulation between column and lintel. Even if the use of iron armatures entailed a distortion necessarily made between appearance and realization, as Antoine Picon writes, " l'usage d'armatures en fer rend possible en réalité une approche des problèmes constructifs fondée sur une perception plus dynamique de la circulation et du report des efforts, une perception seule capable de contreblancer efficacement la gêne née du décalage entre le modèle idéal et les techniques de mise en oeuvre." [54] It was only after the separation of structural mechanics and visual solidity at the end of the eighteenth century that the contradiction finally exploded: When the science of construction began to be separated from architectural theory, the rationalist aesthetics of Laugier and Soufflot, which compromised visual solidity and technical rationality, became difficult to sustain.

While neoclassicism was an architectural ideal based on the absolute model of antique architecture, it was also meant to be a means of controlling production of

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[54] Antoine Picon, Claude Perrault, 1613-1688 ou La Curiosité d'un Classique (Paris: Picard Éditeur, 1988) p. 247: The use of iron armatures made possible in reality to approach the constructional problems based on a more dynamic perception of the circulation and the transfer of stresses, the sole perception capable of counterbalancing the discomfort born out of the gap between the ideal model and the modern notion of structure emerging during the eighteenth century."

architecture from details to the whole through rationalization.[55] During the eighteenth century, architects and engineers were interested in structural research and explored the domain of technology of the past with a renewed curiosity as one can see in the rediscovery of De l'Orme's dome and its modern application in the Halle au Blé in 1783. For neoclassical architects and engineers, the relation between the techniques of construction and architectural form was far from the functionalist aesthetics that the later century rationalists would believe.[56] Instead, the theorists of neoclassical architecture during the eighteenth century tried to subsume the scientific and technological knowledge under the universal systems of classicism. After the divine network of the classical system that had linked microcosm and macrocosm was relinquished, Enlightenment architects and engineers used description and classification as a major tool to systematize empirical scientific knowledge and technology during the eighteenth century.[57] They thus tried to reorganize the universal theory of classical architecture through the exhaustive classification and description of architectural knowledge. In this regard, Jean-Marie Pérouse de Montclos accurately observed: "Neoclassicism is a two faced subject; the obverse presents architectural design, the imaginary world of Piranesi and the Utopia of Ledoux, while on the reverse there appear the technical studies of the architects, builders and the engineers, the publications of the Academy of Science, the detailed analysis of the artisan practice by the Encyclopedists."[58]

This was the basic task that major theorists of eighteenth century French neoclassicism such as Jacque-François Blondel and Pierre Patte assumed. Blondel conceived architecture still as a kind of universal science. By a systematic classification of architectural knowledge, Blondel's neoclassical utopia attempted to salvage the gap

[55] See Antoine Picon, French Architects and Engineers in the Age of Enlightenment, translated by Martin Thom (Cambridge: Cambridge Univ. Press, 1992) p. 25
[56] See Jean-Marie Pérouse de Montclos, "Innovation technique et archéologie des techniques dans l'architecture néoclassique in Les cahiers de la recherche architecturale, no. 18 (1985) p.44-9
[57] See Michel Foucault, op. cit.
[58] Jean-Marie Pérouse de Montclos, op. cit. Also quoted and translated in Antoine Picon, op. cit., p. 292

between theory and practice which was widening with the rationalization of architectural production by engineers. He not only tried to re-integrate structural questions within architectural theory by the theory of distribution, but also tried to reestablish the relation between architecture and society based on the hierarchical model of society. He did this by developing the notion of "character" in architecture--characters depending on ranks and conditions. In short, Blondel's theory of type and character were an effort to preserve the universal order of classicism by reinventing classical system while adapting to the increasing rationalization of architectural production and the development of planning technology. Blondel's theory of character, however, was only a representation the subjective tendency in the theory of architecture, which reflected in turn the increasing gap between the science of building and architectural theory of classicism.

Although Blondel considered "construction" an important part of his comprehensive architectural theory, he did not pay much attention to construction technology itself. The last two volumes of his Cours d'architecture which were devoted to construction, were completed in 1777 by Pierre Patte (1723-1814), a disciple of Germain Boffrand and an Enlightenment architect and engineer. Patte was interested in the technical problems of buildings since his early career and particularly stressed "construction" and "*art de bâtir*" as the most essential part in architecture. In the preface to Mémoires sur les objets les plus importants de l'architecture that he published 1769, Patte described construction as "the most useful, the most necessary and the most essential part of architecture."[59] In this book, Patte included all the available knowledge on building materials and construction technology, including the experiments of Jean-Rudolphe Perronet on the strength of materials in compression. The seventh chapter of his book, entitled "Paralléle des meilleurs moyens usités jusqu'ici, pour construire les plate-bandes, et les plafonds des colonades," was entirely devoted to the methods of iron reinforcement. Here Patte first analyzed the iron reinforcement of the east facade of the Louvre, Ste.- Sulpice and the Palace of Louis

[59] Pierre Patte, Mémoires sur les objets les plus importants de l'architecture (Paris, 1769) p. iii

IV. (figs. 11, 12) His analysis of the examples of iron reinforcement was sound even though the understanding of mechanics of structure was not yet developed. It was not surpassed even by the 1836 edition of Rondelet's L'art de bâtir. [60]

Patte's publication of the methods of iron reinforcement construction in 1769 was part of the encyclopedic interest in the catalogue of technology. It was an attempt to systematize knowledge on architectural technology for the rationalization of the theory of classical architecture. His interest in construction technology, therefore, was different from the other theorists of structural neoclassicism. Following the manner of Frezier and other theorists of structural neoclassicism, Patte argued that proportions of orders were to be determined by structural mechanics, not by human proportion.[61] Patte wrote in 1775 that "The true manner of building consists of proportioning columns to the loads that they must support, a principle which is in accord with judgment, . . .and not optics"[62] and that "the great art of architecture consists in giving only that thickness as required for solidity. . . It can only be through ignorance that one gives more rather than less of it."[63] However, the structural rationality that Patte had in mind was fundamentally rooted in the visual norms of classical architecture. Although he himself was an engineer and technical innovator in urban planning, Patte's main concern was to maintain the visual norms of classical architecture. Thus, when the structural approach of neoclassicism went to a bit of an extreme, as was the case with Soufflot's church of Ste.-Geneviève, Patte opposed it.

Patte's refusal of the engineering approach to architecture and his adherence to classical aesthetics was most clearly demonstrated in the dispute with Soufflot and Perronet on the supporting piers of the church of Ste.-Geneviève. Soufflot designed the church as a

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[60] See Robin Middleton, "Architects as Engineers: The Iron Reinforcement of Entablatures in Eighteenth-Century France," AA Files 9 (1985) pp. 54-64.

[61] For Pierre Patte's theory of proportion, see Introduction and Chapter two, "Dissertation sur les proportions générales des ordres d'architecture, où l'on fait voir jusqu'à quel point il est possible de déterminer," in Mémoires sur les objets les plus importants de l'architecture (1769)

[62] Pierre Patte, Etudie d'architecture (Paris, 1755) Quoted in Mae Mathieu, Pierre Patte: Sa vie et son oeuvre (Paris: Presses Universitaires de France, 1940) p. 112. Translated and quoted in Goerge Teyssot, "Emil Kaufmann and the Architecture of Reason: Klassizismus and "Revolutionary Architecture," Oppositions 13 (1978) p. 69

[63] Ibid.

model of rational architecture and determined the size of the piers by scientific calculation and even carried out an experiment on the strength of materials. After measuring the church of St. Paul in London in 1767, however, Patte criticized the size of the piers of the Ste.- Geneviève, claiming that they failed to respect the traditional relation between the size of the vertical support and the span. Emiland Gauthey, an engineer and architect of the École des Ponts et Chaussées, came in support of Soufflot by calculating the stability of the dome and arguing that the piers would be enough to support the dome. In short, whereas Patte emphasized empirical knowledge, Soufflot and Perronet stressed abstract theory based on mathematical calculation and experiments. Thus, even though Patte referred to science and calculation in his argument against Soufflot's design, it was simply a compromise between tradition and calculation.[64] Despite all his interest in technology, Patte depended on tradition and experience rather than calculation in determining the thickness of the column and supported thick columns which represented visual solidity.

Patte's interest in reinforced lintels with voussoirs seems, then, truly paradoxical; the first architect who published the methods of iron reinforcement of column and lintel, emphasized empirical observation and the visual appearance of solidity. It seems irreconcilable to argue for the traditional visual norms of stability while at the same time advocating the technique of iron reinforcement of the lintels with voussoirs, which distorted the dimension of structural elements given by the natural limit. For Patte, however, the form and the construction process were different matters. Although he stressed the rationality of structure, he distinguished between structural rationality based on visual appearance and the rational process of construction, between visual solidity and structural dynamics based on calculation. For Patte, a rational form might not have a direct relationship with the rational process of construction. In this respect, it seems clear how Patte rejected Gothic architecture as a pure construction, rather than an elevated form of architecture, while he admired the rationality of Gothic structure. Although Gothic

[64] For a detailed discussion, see Antoine Picon, op. cit., pp. 168-180. Also Pérez-Gómez, op. cit., pp. 258-267

structure was fundamentally related in its structural mechanics to the iron reinforced lintels with voussoirs, about which he was an expert, Patte did not appreciate Gothic construction. This was because Patte believed that in Gothic architecture, the constructional principles were directly transferred into its form. It was his aesthetic preference for classical architecture that led him to denounce Gothic style as a tasteless affair, a pure structural solution to the problem of equilibrium. [65]

In separating architectural taste from techniques of realization, Patte was a true heir of Perrault: Like Perrault, Patte was truly a technical innovator in urban planning and construction. As Perrault did, he de-secularized nature and mechanized architectural production, and yet maintained the architectural norms of classicism as most important. In this regard, it is also significant that while Perrault's theory was rejected by most enlightenment architects, Patte was one of the few theorists who advocated Perrault's rational theory. However, unlike Perrault, Patte still shared with his eighteenth century contemporaries the belief that there is an absolute beauty and proportions derived from nature. This was the major difference between Perrault and the eighteenth century rationalist architects and engineers, which also constituted the core of the ambiguity of eighteenth century neoclassicism.

As for the gap between the architectural model and technical rationality, which exists in Patte's theory, however, even Soufflot was no exception. Although Soufflot betrayed the attitudes of positivistic engineers by testing the strength of the materials with a machine he invented, and by using mathematical calculation in determining the dimensions of the piers, his model of rational structure was fundamentally based on the architectural model of classicism. As Pérez-Gómez stated, "Soufflot's position in relation to both aesthetics and mechanics was derived from a belief in a mathematically ordered nature. Scientific observation and experimentation yielded quantitative results that led to the

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[65] See Robin Middleton, "The Abbé de Cordemoy and the Greco-Gothic Ideal," Journal of Warburg and Courtauld Institutes, vol. 25, nos. 3-4 (1964)

establishment of absolute laws. . . A transcendental taste had access to the rules of proportion implicit in the same elemental nature."[66] Thus, despite his attempt to apply scientific and technological rationality to the design of the church, Soufflot's model of rational architecture was ultimately not an engineering construction, but a compromise between the architectural model of classicism and structural rationality. Therefore, the difference between Patte and Soufflot was not so big after all; it was just a matter of degree to which one relies on the scientific and mathematical instrument to determine the proportions of architectural elements. The ultimate point of reference for both was the aesthetic ideal of classicism. Their rationalism was, thus, an inevitable compromise between the architectural model and the mechanization of building, between beauty and efficiency.

The neoclassical effort to reorganize the universal order of classicism without contradicting modern science and technology was, however, an impossible task in the continuing development of science and engineering, and in the mechanization of architectural production. The ambiguous compromise between structural rationality and the architectural ideal of classicism ultimately exploded by the end of the eighteenth century, as scientists and engineers advanced the methods of scientific calculation of structural mechanics and a new dynamic concept of structure based on them. When the conflict between visual solidity and law of physics became clear, the rationalist aesthetic of neoclassicism was difficult to sustain. It became impossible for classical theory to control both aesthetics and construction simultaneously. Based on the scientific studies of material strength and mathematical calculation, the science of construction began to be separated from the architectural theory of classicism. By the early nineteenth century, thus, one witnessed neoclassical theory fragmenting into a pure *art of design* and a pragmatic *science of construction*.

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[66] Pérez-Gómez, op. cit., p. 71

In this architectural situation at the turn of the century, Charles-François Viel, a conservative architect and prolific writer, emerged as the most severe and penetrating critic of eighteenth century neoclassicism. Viel saw this "state of architectural decadence" of the turn of the century as an inevitable consequence of the ambiguity of eighteenth century neoclassical architecture which uncritically pursued the rationality of structure. He doubted the structural rationalists' idea that geometrical exercises and partial knowledge of mathematics, mechanics or statics could provide absolute results. Viel believed that mathematical and geometrical calculation, and engineering precision were insufficient not only in producing good architecture of taste but also in providing the solidity of structure. He wrote in his Dissertation sur les projets de coupoles de la Halle au blé de Paris, published in 1809, that "our experience prohibits us to subordinate the stability of an edifice either to its perfection or to the worker's precision . . . Only in such arts as music and dance does success depend on the quality of the execution."[67]

Ch.-F. Viel perceptively observed that the limitation of the structural rationality of neoclassicism was directly represented in the modern methods of building that had been practiced during the eighteenth century: the techniques of iron reinforcement. He argued that the rationalists' dependence on the abstract theory of structure ultimately brought a distance between the architectural model and the modern techniques of construction, the discrepancy between appearance and reality. In L'impuissance des mathématiques pour assurer la solidité des bâtiments, published in 1805, Viel argued that Soufflot's church of Ste.-Geneviève replaced real acting forces with totally abstract indirect components, producing results that were never in accordance with reality. The consequence of modern architects' simultaneous use of many different systems and materials was, in his opinion,

[67] Charles François Viel, Dissertation sur les projets de coupoles de la Halle au blé de Paris (Paris, 1809) S. 117 f.

that modern buildings became dependent on *forces indirectes*, and thus, both too strong and too weak.[68]

According to Viel, architects must work within a general harmony based on the laws of equilibrium; that is, a material must be disposed according to its nature. Viel contrasted *forces indirectes* practiced during the second half of the eighteenth century to *forces directes* of traditional classical building. He noted that ancients had used only pure geometric forms in their architecture and had achieved structural strength by means of unity of design and construction. The ancients never had recourse to indirect methods of support such as buttressing or secondary reinforcing materials such as iron. Viel then argued that architects had to return to ancient methods of building based on monolithic and homogeneous material, where there was a radical coherence between theory and practice. His ideal of monolithic materials and the continuous structural system diametrically opposed the pragmatic approach of modern architects.[69]

Although based on nostalgic view, Viel's criticism accurately accounted for the contradiction of the eighteenth century neoclassicism. Indeed, there was an ambiguity in the structural rationality of neoclassicism between modern technology and the architectural model of classicism. And as Viel observed, the practice of the techniques of iron reinforcement, which created the distance between the real and the appearance, was the logical consequence of the ambiguous nature of neoclassicism. This contradiction ultimately caused the collapse of the neoclassical theory of architecture. When one pursued the modern techniques of iron reinforcement further with a view to maintaining the rational form of classical architecture, iron reinforcement of stone construction became literally a stone encasement of iron structure, or a simple stone screen with iron structure.[70] In this

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[68] Charles François Viel, L'impuissance des mathématiques pour assurer la solidité de bâtiments (1805) p 25. Quoted in Picon, Claude Perrault, 1613-1688 ou La Curiosité d'un Classique (Paris: Picard Éditeur, 1988)
[69] See Dora Wiebenson, "The two Domes in Halles aux Blés in Paris," Art Bulletin, vol. IV, no.2 (1973) P 276
[70] This point was made by Pierre Saddy. See Pierre Saddy, "A Construct of Modernity: the Re-inforced Lintel," Daidalos 8 (1983) p. 57-61

case, the elements of a classical facade were freed from structural necessity, which enabled architects to express freely their imagination.[71] (fig. 13) Such an architectural expressionism of *voussoir* construction, as it happened in the mid-nineteenth century, was a kind of neoclassical ideal, which Patte, Soufflot, and perhaps even Perrault would never have endorsed.

Thus, if one really wished to maintain the visual norms of classical architecture, there was no other choice but to return to the ancient mode of construction as Ch.-F. Viel argued. However, Viel's ideal of architecture was already anachronistic. With the development of modern scientific methods of calculation and the precision of engineering mechanics, the mechanization and rationalization of architectural production was already a reality and an irreversible process that nineteenth century architecture had to come to terms with. By the early nineteenth century, the techniques of iron reinforcement advanced further, and iron already began to be employed as a construction material in floor and roof structure, replacing timber and stone. The technology of iron construction soon emerged as a new genre of construction, and became an inevitable part of the modern architectural practice. As a result, the dilemma between technology and form became a central issue with which nineteenth century architecture had to come to term.

It should be reminded that the conservative voice that favored the return to the ancient methods of building was still resounding until the 1830s. Quatremère de Quincy, a *doctrinaire* of classical idealism and the permanent secretary of the Academy until 1839, wrote in "Architrave" in his Dictionnaire historique d'architecture, published in 1832: "The use of these monolithic architrave forced ancient architects to close up their columns and give them this harsh appearance resulting in the most impressive effect of their colonnades and peristyles, as well as in the magnificence and the considerable protrusion of the Greek capitals of the Doric order both aimed at reducing the span of the architraves."[72]

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71 This was advocated by an engineer Louis Cloquet. He wrote in his Traité d'architecture (1867) that "it is judicious to bring out the voussoirs which form the flat vault." Quoted in Pierre Saddy, ibid., p. 56

72 Quoted in Pierre Saddy, ibid.

In the item, "Claveau," Quatremère wrote critically of the voussoir construction of modern architecture. He cast a doubt on the solidity of such modern structures and advocated the ancient principle of monolithic construction:

> Dans les pays où les carrières ne sauraient fournir à l'art de bâtir des matériaux assez étendus et assez tenaces pour former les plates-bandes d'un seul bloc, on a imaginé de suppléer à cette insuffisance de la matière par l'art des *claveaux*. Cette ressource, il faut l'avouer, est d'un grand prix: on lui doit de pouvoir élever des péristyles qui le disputent en grandeur à ceux des anciens. Mais peuvent-ils le leur disputer en solidité? C'est ce que le temps et l'expérience n'ont pu encore justifier. Il est douteux même, malgré toutes les précautions industrieuses, les armateurs de fer, les évidements adroits faits pour assurer la durée de ce genre de construction, qu'il parvienne à se faire admirer des siècles éloignés.
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> Mais l'art de bâtir ne saurait être comptable dans chaque pays que des moyens que la nature lui présente, et c'est beaucoup faire à lui que d'éluder, ne fût-ce que pour quelque temps, ses refus, et de vaincre sa résistance.
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> Il semble que les architectes modernes aient regardé l'art des *claveaux* dans la construction des plates-bandes et des architraves comme une de ces victoires que l'art remporte quelquefois sur la nature. Peut-être, à cet égard, se sont-ils abusés trop et trop tôt; peut-être aussi ont-ils mis trop d'ostentation dans l'emploi de ces moyens, qui ne seront jamais qu'un faible équivalent des ressources que la nature a refusées à certains pays.
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> . . .quelque heureuses et sûres que puissent paraître les ressources de l'art des *claveaux*, l'œil ne voit pas sans inquiétude ces plates-bandes formées d'une multitude de parties dont il prévoit la ruine et la décomposition. Il semble que l'intérêt de l'architecture serait de cacher ces moyens, au lieu d'en faire parade comme on le fait quelquefois si indiscrètement en marquant avec tant de soin l'appareil des claveaux. Rien ne dément plus l'idée de solidité nécessaire à un architrave que cet assemblage de claveaux dont les joints, s'altérant bientôt par les injures du

temps éloignent de plus en plus l'apparence d'intégrité et de continuité que demande la maîtresse poutre de l'édifice. [73]

In his article, "Architecture," published in Encyclopédie nouvelle (1834), Léonce Reynaud, a rationalist engineer-architect and a leader of reform movements of architecture of the 1830s, also criticized the use of iron reinforcements in neoclassical architecture. His criticism, however, was based on the diametrically opposing view to Quatremère's. Instead of returning to the absolute principles of Classicism, Reynaud advocated a search for a new rational form of architecture based on the modern technology. Discussing the use of iron reinforcements in neoclassical architecture, Reynaud provided a penetrating critique of the contradiction of the iron reinforced lintel. He wrote:

> Mais un principe d'imitation avait été posé, et il fut poursuivi jusque dans ses dernières conséquences. Après avoir emprunté aux monuments de l'antiquité formes de détail, on chercha à imiter les rapports et les dispositions de ces détails, et on finit par considérer ces monuments commes des types absolus de beauté. . . C'est que les architectes, pour se former un style que d'anciennes traditions peuvent seul donner, avaient dû consacrer de longues années à l'étude des monuments antiques, et n'avaient pu acquérir les connaissances nécessaires pour la juste appréciation des ressources que leur offraient nos sciences et notre industrie. Ils devaient d'ailleurs repousser des sciences qui accusaient leur procédés de construction, puisque les formes qu'ils employaient avaient été dictées par une organisation scientifique beaucoup moins avancée que la nôtre. Cependant quelques procédés modernes étaient trop évidemment avantageux pour qu'on pût y renoncer; tels étaient ceux qui permettaient l'emploi de

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[73] Quatremère de Quincy, "Claveau," Dictionnaire historique d'architecture (Paris, 1832): "it seems that modern architects have considered the use of voussoirs in the construction of flat vault and architraves as one of these victories over nature. In this respect, they have perhaps misled themselves to a too large extent, and too early; they may also have used these means too ostentatiously, which from now on, represent a faint equivalent to the resources that nature has refused to certain countries....

.... However fortunate and sure the resources of the technique of the voussoirs may appear to be, the eye still does not see without some concern these flat vaults formed by a multitude of parts bound to destruction and decomposition... Nothing denies more the idea of the necessary solidity of an architrave than this assembly whose joints, soon altered by the insults of time, banish more and more the appearance of integrity and of continuity required by the main bulk of the edifice..."

petits matériaux: ils furent conservés. Les architraves et les frises ne furent plus formées de monolithes portant à la fois sur deux points d'appui; on les construit en plusieurs claveaux comme les voûtes. A une époque on emprunta la forme, à une autre le mode d'exécution. Mais le mode d'exécution ne convenait à la forme; car ces voûtes plates sont de toutes les voûtes celles qui exercent les plus grandes poussées, et des colonnes ont trop de hauteur sur un faible diamètre pour pouvoir les contenir. Aussi nos grands monuments ne durent-ils leur stabilité qu'aux *barres de fer* qui s'y croisent dans tout les sens, et il est facile de prévoir que cette stabilité sera fort limitée. Ainsi, nos édifices modernes ne présentent ni l'expression qui appartient à l'art, ni les dispositions réclamées par nos usages et notre climat, ni la solidité que notre science permettrait d'obtenir. Loin de représenter notre societé sous toutes ses faces, ils ne la représentent sous aucune.[74]

This rationalist criticism of iron reinforcement of stone structure was shared by Eugène-Emmanuel Viollet-le-Duc, a Gothic rationalist in the mid-nineteenth century. In his Entretiens sur l'architecture published in 1863, Viollet-le-Duc rejected the iron reinforced lintel because of the discrepancy between real and appearance.[75] Arguing for an honest and appropriate form derived from its material properties and the construction method, he attempted to propose a new form of modern architecture. However, Viollet-le-Duc's proposal was also based on his aesthetic preference; this time, it was the Gothic instead of the Classical. In short, as the return to the ancient principles of building before the development of modern technology was impossible, so was the creation of a new form with the modern technology. This was the fundamental dillema of rationalism between technolgy and form, as I will discuss in later chapters.

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[74] Léonce Reynaud, "Architecture," Encyclopédie nouvelle (Paris: Gosselin, 1834-41) pp. 777-778
[75] See Pierre Saddy, op. cit., p. 61

Chapter Two. From Iron Reinforcement to Iron Construction: A Crisis of Classical System and the Emergence of Iron Construction, 1780-1815

It is commonly held that after the modernization and industrialization of the production of iron, the evolution of iron construction paralleled the development of scientific knowledge on the resistance and the structural behavior of the material, and the mathematical theory of structural mechanics.[76] According to this argument, since iron has a greater resistance than traditional material such as stone and wood, it was possible to make finer, more linear and less redundant structures than with the traditional materials. As the development of structural mechanics allowed the structural elements to be analyzed mathematically, it became possible for new forms or new assemblages of iron construction to evolve according to the method of mathematical calculation, even though the intuition of the builders and habit continued to play an important role for a considerable time.

Although scientific and technological advances were undoubtedly essential factors for the evolution of iron construction, this alone cannot explain the emergence of iron construction in the late eighteenth century. The fact that early iron construction owed little to the scientific understanding of the material strength or of modern structural mechanics testifies to this; as for construction technology, early iron construction was based on either traditional techniques of timber and stone construction, or their reinvention. Although systematic experiments on the strength of iron had been conducted since the late seventeenth century in keeping with the rationalization of architecture, neither scientific

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[76] See Bertrand Lemoine, "Théorie et Expérimentation," L'Architecture du fer, pp. 31-42 and Steiner, op. cit., Chapters 1 and 2

understanding of the material properties of iron, nor structural mechanics significantly advanced. During the eighteenth century, observations concerning the strength of material were experimental and without a common conceptual frame work. [77] Its relationship with the mathematical theory of physics came much later; it was after the 1830s that empirical observation of the strength of materials was integrated into the mathematical structure of theory. [78] And the scientific theories of structural mechanics, which incorporated the experimental data on the strength of iron into building practice, began to affect the conception of new forms and new assemblages of iron construction only after the mid-nineteenth century.

During the eighteenth century, despite scientific experiments on the resistance and the structural behavior of materials, the economy of material and structure was tested within the limits set by the eyes of spectators. It is not surprising, then, that regardless of empirical knowledge on its strength, iron was not considered a proper construction material; being the strongest material of all, it was used mainly to reinforce a masonry structure. For example, Pierre Patte, although he was an expert on the techniques of iron reinforcement, considered iron an untrustworthy aid to construction because of its fragility and its tendency to rust. When he recognized the use of iron rods as a substitution for flying buttresses in Gothic churches, Patte simply dismissed the role of the columns in supporting the vaults in Gothic construction.[79] There is little doubt that Patte's concept of stability was based on the visual norms of traditional stone masonry construction. Thus, apart from its fragility, the visual slenderness of iron was clearly a factor that had determined his mind. Besides the visual appearance of solidity, formal concepts of

[77] There was no clear framework until Lagrange paved the way for the nineteenth century re-organization of knowledge by the publication of Mécanique analytique in 1788. See Antoine Picon, op. cit., pp. 312-316

[78] As early as 1707-1708, Antoine Parent presented a paper on the resistance of timber beams to the Academy and in 1711 Reaumur presented a paper on the resistance of steel wire. In 1729, Pieter Van Musschenbroek published in tabular form the compressive and tensile strengths of various kinds of wood and metal. In the mid-eighteenth century, Soufflot experimented on the resistance of the stones and undertook series of measurement of the expansion of iron with his friend Perronet, the engineers of the Ecole Ponts et Chaussées.

[79] Pierre Patte, Cours'd'architecture VI (Paris, 1779) p. 216. Quoted in Robin Middleton, "Abbey Cordemoy...," p. 114.

neoclassical theory such as "*character*" and "*convenance*" also prevented iron from being used as a construction material since those concepts were based on the classical norms of orders and proportions of stone construction. For example, Perronet, an engineer and the first director of the École des Ponts et Chaussées, rejected the iron bridge which Montpetit proposed in 1779 on the ground that it lacked the *convenance* of a monumental stone bridge.

Thus, in order for iron to be used as an explicit building material, it was absolutely necessary to overcome the concept of solidity based on visual geometrical rules and the formal norms of classical architecture based on traditional stonemasonry construction. In France, the iron industry was not modernized until 1830 and the neoclassical theory of architecture was especially dominant. Therefore, the emergence of iron construction should be explained in relationship with the crisis of the neoclassical tradition. In other words, it was the crisis of the classical theory of architecture in maintaining the universal system of the Classical Age--"permanent space of representations in their ordered relation"-- and the dominance of engineering approaches in architecture since the late eighteenth century that opened up a space for iron to be utilized as a proper construction material.[80] The crisis of classicism became evident in the latter part of the eighteenth century, between 1780 and 1800, when the engineer's new approach became dominant in the production of architecture. The engineers' new paradigm of architecture brought with it a more technological and practical attitude in the production of architecture and a dynamic concept of structure, which enabled them to experiment with iron, applying it to various parts of construction.

The rationalist theory of architecture during the eighteenth century, while arguing for the rationality and economy of structure, was still based on the architectural model of

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[80] In this sense, it is very interesting to compare the situation of France with that of England, where iron had been used as a substitute for stone columns since the late eighteenth century. In France, where classical theory of architecture was dominant, iron was used mostly for concealed roof and floor structure. It was only after the late 1820s, when the classicism of the Academy was dismantled, that cast iron columns were produced and employed in architecture, replacing stone columns.

classicism and the geometrical concept of visual solidity, rather than on modern structural mechanics. Thus, as discussed in the previous chapter, the architectural ideal of neoclassicism with free standing columns was realized by a systematic iron reinforcement of masonry structure. The balance between the technological rationality and the architectural model of classical architecture maintained by the neoclassical theories was then an ambiguous and contradictory one, one that could be understood only by eighteenth century minds.

The contradiction between the two models of neoclassical architecture, however, had already revealed itself in the debate concerning Soufflot's church of Sainte Geneviève around 1770. The debate on the size of the piers supporting the dome of the church was between Patte, on the one hand, and Soufflot and his engineer friends, Perronet, and Gauthey, on the other hand. When Soufflot carried his rationalism to an extreme, determining the size of the piers by calculation, Patte came forward, criticizing it in the name of visual norms of classical architecture. In his report published in 1771, Patte argued that the size of the piers designed by Soufflot was to small to support the dome.(fig. 14) Although he used mathematical knowledge in his argument against Soufflot, Patte's notion of stability of construction was based on tradition and visual appearance. Against Patte's criticism, Perronet and Gauthey took Soufflot's side, claiming the stability of the piers. They even carried out experiments on the strength of the stone. However, as I discussed in the previous chapter, their positions were not entirely different from Patte's. Although they used scientific experiment and calculation, their concept of structural rationality was still based on the static model of classicism. Thus, as Antoine Picon writes,

> What Soufflot, Perronet and Gauthey . . . sought was a new type of dialogue between mathematical formalism and experiment, a dialogue involving, somewhat paradoxically, both a fresh challenge to the traditional assumption of the science of construction, and a whole series of gropes and

> compromises; to calculate but to distrust calculation, to innovate but to rely upon tradition.[81]

However, while arguing for the stability of the structure, the engineers Perronet and Gauthey revealed a dynamic understanding of the science of construction. For example, Perronet's analogy of Gothic construction with an animal skeleton demonstrated a dynamic concept of structure based on forces and resistance, rather than the traditional static concept of structure based on piling up of stone pieces and their weight, which Patte relied upon. Gauthey, on the other hand, tacitly revealed in his report on the structure of Saint Geneviève, the contradiction between the architectural model of classicism and the dynamics of structural mechanics, by hinting at the possibility of the total removal of the piers.[82] Robin Middleton made this point in his recent article. He writes:

> In the early 1770s, when Patte and Emiland Gauthey were disputing the structure of Sainte Geneviève, Patte was unable to grasp the concept of inclined forces within the dome. Gauthey, the engineer, shared Patte's aesthetic aims, but he was willing and able to envisage alternatives based on engineering parameters. Gauthey demonstrated that the four supporting piers of Soufflot's dome could, in mechanical terms, be altogether eliminated, provided that ranking buttress were designed to carry the thrusts right down to the ground.[83]

In fact, the objectives of the engineers and their approaches differed from those of architects from the beginning. The corps of engineers, first established in 1716 for the production and the maintenance of highways and bridges, was concerned with the

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[81] Antoine Picon, French Architects and Engineers in the Age of Enlightenment p. 118

[82] E.-M. Gauthey, Mémoires sur l'application de principes de la mécanique à la construction des voûtes et des dômes (Paris, Dijon, 1771), especially p. 4, 5

[83] Robin Middleton, "Architects as Engineers: The Iron Reinforcement of Entablatures in Eighteenth-Century France," AA Files 9 (1992) p. 62

reorganization of spaces through the rationalization of territory.[84] Their objectives, however, were hampered by lack of technological and scientific tools. Thus, until the mid-eighteenth century, there was actually no clear distinction between architects and engineers except in their objectives. Architects such as Gabriel and Boffrand were members of the *Corps des Ponts et Chaussées* and built bridges and fortifications, while engineers shared the concerns of architects on neoclassical notions such as "characters" and "imitation of nature." However, with the establishment of the École des Ponts et Chaussées in 1747, engineers' approaches began to take shape with their own knowledge and practice based on the rationalization of spaces and construction processes.[85] The difference between engineers and architects was, as Picon wrote, that "while architects sought to base their vocabulary upon the imitation of nature, engineers located their work within a continuous process, from the initial moment of invention to the effective realization on the building site."[86] In order to rationalize the construction processes, engineers exhaustively described a project from the technology employed and the quantities and prices of materials to its final form through drawings and written descriptions. By doing so, they formulated the construction processes into homogeneous data. Thus, calculation began to play an important part in engineers' projects although the methods were simple and approximate. Drawings and written descriptions that the engineers used also paved the way for a correlation of conception and realization. While architects were interested in the static analysis of parts and proportions of works, engineers moved towards a dynamic vision of construction based upon homogeneous data.

The model of engineers' approach was bridge building. Unlike the previous ages when bridges were constructed in a massive form in order to sustain the floods by their

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[84] The rational reorginization of spaces and territoy had started since the mid-seventeenth century with development of commerce. Colbert was the one who initiated this rationalization of territory under the reign of Louis XIV.

[85] For a detailed discussion of the long process of establishing the engineering approach from the Ecole des Ponts et Chaussées to the Ecole Polytechnique (1796), .see Antoine Picon, op. cit, pp. 99-139, and also Peter Collins, "Chapter 18. The Influence of Civil and Military Engineers," Changing Ideals in Modern Architecture (Montreal: Mcgill-Queen's Univ. Press, 1978)

[86] Picon, Antoine, op. cit., p. 107

own weight, bridges in the age of Enlightenment were designed with flattened arches and narrower cross section of piers with increased spans.[87] In Perronet's Pont de Neuilly, built between 1768 and 1772, the sizes of the piers were reduced to one tenth of the span from traditional one fifth, and the form of arches was flattened with eleven different radii.(fig. 15) In order to span the longer distance between piers, the engineer used calculations based on material strength and mechanics. Perronet's Pont de Neuilly was the first bridge for which a form work was designed on scientific principles and the sizes of piers were calculated accurately according to the loads to be carried. In order to increase the span of the arches further, Perronet invented the system of the stretched arch in the Pont Louis XVI, built between 1787 and 1791.(fig. 16) The system of stretched arch was achieved by means of a single arc of a circle with a large radius, rather than many different radii.

One of Enlightenment engineers' contributions to construction was the abstract way of dealing with structural elements. Before 1750, columns and piers were thought of as simply standard elements of the Classical orders, and their dimensions and shapes should not be changed. However, the flattened arch and the reduction in the piers increased the horizontal thrusts, which were transmitted from arch to arch. In Perronet's bridges, thus, the traditional model of structure, which was framed by girders all in equilibrium, was replaced by a dynamic model with arches counterbalancing each other by shifting the stress onto the abutment piers. It provided a new dynamic concept of structure with horizontal thrusts between arches, and the new structural notion of point support. "The term, point support," as Peter Collins writes, "helped rid architects of the notion that a pier or column must necessarily have some predetermined form or shape regardless of the material of which it was made."[88] Perronet even desired replacing the piers with freestanding

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[87] The first bridge where the so called bucket-handle arches were used, was Gabriel's Pont de Blois, built in 1716. Perronet's Pont de Neuilly was a masterpiece of this new model of bridge building.
[88] Peter Collins, op. cit., p. 188

columns in the proposal for the Pont Saint-Maxence. (fig. 17) Perronet's dynamic model of the bridge, in a sense, was a direct critique of Laugier's model of the primitive hut.[89]

With the development of the engineers' approaches, it became increasingly difficult for traditional classical theory of architecture to control architectural production. The dispute over the church of Ste.-Geneviève took place exactly at the moment when the neoclassical approach to construction, based on geometrical reasoning and upon formulas of empirical dimensioning, was all but exhausted. With the development of the engineering approaches based on the rationalization of architectural production and the dynamic concept of structure, the ambiguous compromise of the structural rationalists' approach between the architectural model of classicism and the rationality of structure finally exploded. Soufflot's incessant pursuit of structural rationality inevitably led his architecture to the point where it clashed with classical norms. In the debates, while architects such as Patte tried to maintain the static model of classicism, engineers such as Perronet and Gauthey, regardless of their limitation, could finally recognize dynamics of structure. The debate over the stability of the church of Ste.-Geneviève resembled in many ways the contemporary criticisms of Peronnet's bridges.

Despite the theoretical efforts to re-invigorate classicism by Blondel and Patte, towards the end of the eighteenth century, the crisis of the classical theory was evident. The engineers' science of building separated from neoclassical theory of architecture.[90] The advances of the methods of mathematical analysis during the late eighteenth century by engineers such as Coulomb, Lagrange and Prony, greatly helped to change structural mechanics from the synthetic manner of Euclidean geometry to the analysis of the threshold

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89 Picon pointed out that the advances made in the technology of flat arched construction and in the structural understanding of it had a close relationship with the construction of the neoclassical lintel with voussoirs where columns support an entablature constructed with voussoirs. (See Antoine Picon, French Architects and Engineers in the Age of Enlightenment, p. 160) However, I woule like to disagree with Picon's analogy between the bridge and the debate on the structure of the church of Ste.-Geneviève. While bridges were based on the dynamic notion of structure, Soufflot's model of rational church was based on the Laugier's idealized model of classical architecture.

90 This can be demonstrated clearly by the comparison between J.-F. Blondel and Prony as Picon analyzed. See ibid.

and limit. The static and universal paradigm of classical architecture contradicted the emergence of the dynamic concept of progress and development. As the conflict between visual solidity and laws of physics became clear, engineers were finally able to go beyond the Vitruvian paradigm of solidity.

When the aesthetics of classicism was in crisis, engineers made their discourses without reference to aesthetic principles. As the weaknesses of the basic assumptions of classical theory became obvious, formal issues in design such as "taste" and "*convenance*" ceased to have much significance for engineers, and lost their meaning in engineers' discourses although they remained the basic point of reference for architects. For example, although the concept of utility in engineers discourses used to include the concept of *convenance*, by the end of the eighteenth century, it was freed from *convenance* and concerned itself solely with imperatives of a technical kind.[91] Since around the 1780s, utilitarian and practical concepts in architecture such as "public utility" and "technicality" began to be emphasized more than formal design-oriented concepts such as *convenance* even among rationalist architects. With emphasis on efficiency and economy, rational-minded architects and engineers delved into the technical and practical problems in architecture since the latter part of the eighteenth century.

It was in this context that iron, traditionally a reinforcing material, began to be used or considered as an effective construction material in France. The decade of the 1780s was a period of rising interest in cast iron in France. In 1785, a cast iron foundry using coke as a fuel and a steam engine, was first founded in France at the site of Le Creusot. In the following year, Monge, Vandermonde, and Berthollet reported on iron fabricated in the new plant and presented a paper to the *Academie des Sciences* on the different states of iron. However, already beginning in 1779, French engineers made proposals for

[91] Antoine Picon, op. cit., P.112

constructions built entirely of iron, and a few rational-minded architects employed iron as a construction material substituting for traditional material such as wood and stone. [92]

Insofar as iron construction is concerned, bridge construction was the most important domain in which new engineering theories and techniques were applied, since, as discussed earlier, a bridge was the model for engineers' new approach based on mathematical calculation and rationalization of production. As early as 1779, when the famous Coalbrookdale bridge was constructed in England by Abraham Darby III, two proposals for iron bridges were made by French engineers, Jean François Calippe and Vincent de Montpetit. Calippe designed a wrought iron bridge of a bow string arched girder, the main members being composed by wrought iron plates on edges with the upper and lower cords connected by vertical and rods and diagonal braces. Montpetit's proposal was original in that he used iron voussoirs following the model of a masonry vault, instead of adapting a timber frame structure.(fig. 18, 19) Guyton de Morveau, a celebrated chemist, wrote in his reply to Montpetit's proposal: "Iron being the most solid of all materials of construction, I have often thought that one could apply it to use. . . particularly to the buildings of arches over large rivers,"[93] and he proposed his own idea on the wrought iron bridge with arched ribs. In the following years, engineers made various attempts to promote construction of iron bridges: In 1783, Léonard Racle proposed a flat vault made of *claveaux en châssis*; in 1786, Nicolas d'Aubry proposed an arch composed of a treilles of iron bars (fig.20); in 1790 de Rosnay submitted a patent for a system of cast iron bridge (fig. 21); in 1790, a competition for an iron bridge was held in the École Polytechnique by the initiative of Perronet.[94] (fig.22)

These proposals for iron bridges were, however, unrealized for several reasons. First of all, the major obstacle to the construction of iron bridges in the late eighteenth

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[92] Frances Steiner, French Iron Architecture p. 20

[93] Albert de Lapparent, Le Siècle du fer, p. 24, Quoted in Frances Steiner, ibid.

[94] For a detailed discussion of the early iron bridges, see James, J.G. "Iron arched Bridge Designs in Pre-Revolutionary France," History of Technology (1979) pp. 64-69; Bertrand Lemoine, "Les ponts métalliques," L'architecture du fer, p. 98.

century was extraordinarily high construction cost. Iron was too expensive to be used in construction since the iron industry was not modernized in France. Charged by the *Académie des Sciences* a report on the iron bridges by Montpetit and Racle, Peronnet insisited on their high cost and incompetiveness in comparison to masory structure: "Nous pensions . . . que l'on ne doit pas construire de trop grandes arches en fer parce qu'elles pourraient coûter à peu près autant que celles faites en pierre dure et qu'elles ne seraient pas aussi solides."[95] When the competition for iron construction was held in 1790 at the École des Ponts et chausées, the major reason why it was declined was that the implementation of iron bridges was considered as yet too expensive. It was only after 1800 that iron construction could be implemented at a competitive price. Emiland Gauthey, the general inspector of the Ponts et Chaussées, published a memoir on iron bridges in 1800. After comparing five different kinds of bridges, of which three were of iron, he concluded that iron is competitive especially in a long span bridge.[96] Besides the high construction cost, the material quality of iron remained as a problem. Most engineers still doubted iron's capability as a building material because of its fragility. As Patte already had mentioned in his technical treatises, published in the 70s, the majority of his contemporary architects and engineers contrasted the durability of stone with fragility of metal and its tendency to corrode in the air, and did not dare to undertake construction in the new material.

Construction cost and the material quality of iron, however, were not the only reasons why iron bridges were not built in France. In France, where neoclassicism was dominant more than in any other country, aesthetic weakness of iron was another important reason. Because of its visual slenderness, iron was not considered as a proper construction

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[95]Antoine Picon, "Les premiers pas de la construction en métal," in Architecture et métal in France 19e-20e Siècle (Paris, 1994) p. 53. Originally in J.-R. Perronet, Etude d'un projet d'arche en fer de 200 pieds d'ouverture. Rapport fait au nom d'une commission composée de MM. Trudaine de Montigny, Perronet et Vaucanson, membres de l'Académie des Sciences, sur un projet de M. de Montpetit, 1779, ENPC manuscript, MS 2609. I found this article after I completed the chapter, where he developed almost the same line of the arguments as I on the emergence and reception of iron construction in the late eighteenth century. However, Picon did not explain the relationship with the iron floor and roof system, he only explained iron bridges.

[96] Bertrand Lemoine, L'architecture du fer, p. 98. Originally in Gauthey, Mémoire sur les ponts en fer , An 8, E.N.C.P. manuscript 233, t.24.

material. Even Perronet was not sure of using iron as a construction material because of its lack of *convenance*. In his report on Montpetit's 1779 proposal, Perronet expressed his doubt on the use of iron in the bridge because it lacked "the monumental character of grand construction dressed in stone."[97] Even when iron bridges were considered as useful as a work in masonry after the turn of the century, aesthetic concepts of classicism continued to be the critical tool to assess iron construction.

While the proposals for iron bridges were rejected, iron construction did emerge during the 1780s in France as an economical and practical solution to the problems of construction. It was for floor and roof framing that iron was used experimentally, replacing traditional timber structure. Since iron was considered fire resistant, iron replaced the traditional timber frames of roof and floor structure in order to make a building fire resistant. Almost all of the early iron structures were built after fire destroyed a timber structure as in the cases of the Théâtre Français and the Hall au Blé. Moreover, since iron had a greater resistance than wood and stone, a larger space could be spanned with a lighter structure. However, the most important reason why iron could be used in roof and floor framing was that they were not visible decorative elements of architecture. Thus, it was possible for iron to be employed as a construction material to solve the technical and practical problems of construction without challenging the visual norms of classical architecture.

The first iron constructions ever built in France were the iron staircase of the salon of the Louvre and the roof frame which covered a stair hall leading to the Grand Salon and the Grand Gallery which were to serve as the first public exhibition chambers in the Royal Palace.[98] (fig. 23, 24) In 1774, as Le Comte d'Angiviller became the Director General of Buildings, the Louvre was transformed to a national gallery of art in order to exhibit the

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97 Antoine Picon, op. cit., p. 112. Originally in J.-R. Perronet, Etude d'un projet d'arche en fer de 200 pieds d'ouverture

98 Frances Steiner, op. cit., p. 23. For the detail of the process of the construction of the gallery, see James L. Connelly, "The Grand Gallery of the Louvre and the Museum Project: Architectural Problems," JSAH 31 (May, 1972)

artworks in possession of the royal family to the public. In changing the Louvre to a museum, however, there were several architectural problems to be solved. As Jacques-German Soufflot, the Intendant General of Buildings and the architect of the church of the Ste.-Geneviève, noticed in 1776, the existing wooden staircase entering the Grande Gallerie was too weak to support the mass public, and it was necessary to rebuild the Gallery's vault as protection against fire.[99] In 1779, Soufflot designed an iron staircase and a roof frame composed of wrought iron members. It was constructed between 1780 and 1781, after Soufflot's death, by his assistant Maximilen Brébion. Although they were not full scale structures made of iron, these were the first of any kind of iron construction built in France. Another problem in transforming the Louvre to a public gallery of art was the lighting of the Grand Gallerie. Lighting was important not only for the exhibition of the paintings but also for their maintenance. Because it was the first public gallery, the method of lighting the Grand Gallery entailed much architectural and technological debate. After a decade long debate on the issue, which involved the Academy, an overhead lighting system designed by Jean August Rénard was finally chosen. In order to make it fireproof, it was covered by an iron lantern in 1789.[100]

Iron floors were constructed in France a few years after the first iron roof frame. In 1785, an engineer Eustace Saint-Fart (1746-1822) built some floors and vaults with hollow pots and small wrought iron ties although the principle weights were carried on timber beams.[101] In the same year, Ango, a *serrurier*, developed an open web wrought iron beam with armature joists, and employed it in the house of a M. Pankouche in Boulogne-sur-Seine.[102] Ango's beam was, the Commission of the Académie Royale d'Architecture

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[99] Ibid.
[100] Ibid., p. 130-1.
[101] Charles Eck, Traité de construction en poteries et en fer (Paris: J.C. Blosse, 1836-41) p. 3
[102] J.-B. Rondelet, Traité..., P. 313. However, according to James, "a model of Ango beam was referred to in Journal de Paris, 8 (Jan. 1792) A full size of floor was built for reviewing by the Academie Royale d'Architecture in July. But it was unsuccessful: the light ribs were unable to support a conventional heavy floor... However, the introduction of the lightweight hollow pot floors led to the successful re-promotion of Ango' ribs from 1785 onwards." J.-G. James, "Iron arched Bridge Designs in Pre-Revolutionary France," History of Technology (1979) p 95

reported,"very sturdy, without any movement."[103] (fig. 25) It was copied until the 1840s with only minor changes.[104] Ango's system was also applied to roof framing. The wrought iron roof structure of the Théâtre Français in Bordeaux, built by Victor Louis between 1786 and 1789, was the first kind of iron roof structure influenced by the Ango system which was practiced in the late eighteenth century. (fig. 26)

The iron flooring system with hollow pots that Saint Fart and Ango invented were very closely related in their basic principles to the technique of iron reinforcement of voussoirs. In English mill factories, iron floor systems were made with simple cast iron plate bars without armatures. However, the French, without the advantage of the cheap cost of cast iron which was favored by the British industry, sought to develop the most economical means of spanning floors with the expensive material. The Ango beam was designed, as Rondelet explains, to augment the stiffness of the beam without increasing its weight because of its high cost.[105] Although wrought iron is eight time stronger than stone, making a beam of iron with a rectangular section would be far less economical than wood.[106] Thus, as Rondelet writes, "..pour éviter d'employer de grosses barres, on a imaginé des espéces de fermes ou armatures, qui donnent plus de raideur au fer, et en augmentent la force en plus grande raison que le poids."[107] It is probable that Ango's idea of using wrought iron armatures to stiffen an arched beam was developed out of his experience in the techniques of iron reinforcement which had been in practice in France since the mid-eighteenth century. The techniques of iron reinforcement had been elaborated and culminated in the entablature of the church of Sainte-Geneviève which was worked out by Rondelet in 1770.[108] By the end of the eighteenth century, the techniques of iron

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[103] Rondelet, ibid.
[104] Frances Steiner, op. cit., p. 23. Floors which used Ango beams were illustrated in Charles Eck, Traité de construction en poteries et en fer (Paris: J.C. Blosse, 1836-41)
[105] J.-B. Rondelet, op. cit., vol. III, p. 313
[106] Ibid., vol. 7, book III, p. 312
[107] Ibid., p. 313
[108] For a detailed description of the iron reinforcement of the entablature, see Rondelet, Traité théorique et pratique de l'art de bâtir, book 7, p. 302

reinforcement became so popular that even the use of iron reinforcement in the lintels over windows and doors had became a standard construction practice.[109] Thus, it is probable that the iron floor system made of wrought iron armatures was derived from the techniques of iron reinforcement.[110] Frances Steiner also made this point in passing: "that Ango's joists were called "armatures" which was applied to the reinforcing of masonry construction suggests that Ango's design may have been derived from a method of reinforcing timber beams."[111]

Although iron was used as a construction material in floor and roof frames during the late eighteenth century, construction made entirely of iron was not realized in France until the nineteenth century. Despite the collapse of the neoclassical system of architecture, in order for iron construction to be realized, it seems that institutional changes in the system of architectural production were to be required. These institutional changes came after the 1789 Revolution. The Revolution brought with it fundamental changes in the architectural institutions which would significantly affect the future state of architectural production and especially the emergence of iron construction: the Academies were abolished in 1793; Ecole Polytechnique was established in 1794 as a preparatory school for the Ecole des Ponts et Chaussées; in 1795, the new Institute de France was created, which soon became the focus of power. The Institute was divided into three classes: physical science and mathematics; moral science and politics; and literature and the fine arts. The third class of fine art was divided in four sections, painting, sculpture, architecture and music, each section having only six members.[112] As a result, the role of architects in the fine arts section of the new organization was greatly diminished to aesthetic theory. They were no

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[109] See C.-F. Mandar, Etudes d'architecture civiles (Paris: Carilian-Goeury, 1826)

[110] James pointed out that Calippe, a serrurier, was the originator of the iron bow string design. Ango's wrought iron bow string girder was influenced by Calippe's proposal for iron bridge in the late eighteenth century. See James. op. cit., p. 69. Calippe's design wrought iron bow-string arched girder must have developed out of his experience of iron reinforcement.

[111] Steiner, op. cit., p. 22

[112] for a detailed discussion of the reform and the Bâtiments Civils see George Teyssot, "Planning and Building in towns: the system of the Bâtiments Civils in France, 1795-1848 " in The Beaux-Arts and Nineteenth Century French Architecture. (Cambridge: MIT Press, 1982)

longer responsible for the control of public buildings: Instead, this was given to the Conseil Bâtiments des Civils which was newly established in 1791 as a part of the Ministry of the Interior. In 1795, after the interlude of the Convention, the Conseil des Bâtiments Civils was re-organized to take over the power of the Commission des Artists. "This further concentration of power [in the Bâtiments Civils] within a state institution reinforced a trend that had already been remarked at the end of the ancient regime; there was now, not just a split between those who upheld taste and beauty and those who dealt with practical problems in the role of technicians and administrators, but, with the clear demarcation created between the Beaux-Arts and the Bâtiments Civils, a final break between the world of individual creativity and that of the systematizers."[113]

The implication of all these institutional changes was that engineers and their practical approach dominated in architectural production. As George Teyssot writes, "engineers had become crucial to the state, not only in military exploitation, but in the centralization of control and the organization of public works throughout the new republic and its conquered territories. During the Consulate and Empires, the engineers of the Corps des Ponts et Chaussées, gradually replaced architects as the instruments of state control of building."[114] In the new institution, thus, architecture was separated between high art and engineering. While engineers were controlling the production of architecture in general, the role of architects was significantly reduced to high art.

In spite of the dominance of engineers during the Empire, it seems that the actual realization of iron construction owed greatly to Napoleon's personal preference for iron. It is well known that Napoleon was very much interested in science and engineering. His election as a member of the first class, scientific division of the Institute de France in 1798, proved this. Thus, it is natural that Napoleon tried to advance the iron industry. However, there were several other reasons why he had a special interest in the iron industry. First, the rivalry between England and France played an important role. In England, iron had

[113] Ibid., p. 35
[114] Ibid.

been used for structural elements in functional construction such as bridges and factories for the practical reason of economy, lightness, the need of larger space and fireproofing. Second, Napoleon supported iron construction as a symbol of the military and economic power of his new Empire, although he preferred classical architecture for monuments.[115] Another reason for his interest in iron was economics; he needed to alleviate the unemployment of iron workers by promoting the industry.[116] His interest in iron construction was shown in several episodes ; in the early nineteenth century, in the midst of the controversy over the churches of Saint-Geneviève, Napoleon suggested replacement of the piers of the Ste.-Geneviève piers with iron columns. He also ordered the construction of the cast iron Vendôme at the Place Vendôme.[117]

Napoleon's proposals for the use of iron, however, were not carried out in most cases. The cost of iron was still extraordinarily high and his architects, Fontaine and Percier, persuaded him that iron was not an aesthetically appropriate material for architecture. However, as far as bridge construction was concerned, Napoleon insisted on the use of iron. In 1801, when the construction of three new bridges was being considered to be built by a private company, two of which were to be constructed of iron, Napoleon chose a design with cast iron for the bridge at the Louvre in spite of his advisory architect's recommendation of stone. The cast iron bridge was constructed between 1801-1803 by Louis-Alexandre de Cessart, an engineer of Ponts et Chaussées, assisted by Jacques Dillon. Although it imitated timber structure, the cast iron bridge, called Pont des Arts, was the first iron bridge built in France.(fig. 27)

When the Pont des Art was completed, it aroused fierce criticism from architects because of its non-classical aesthetic quality and even provoked a strong reaction against

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115 Frances. H. Steiner, "Building with Iron: A Napoleonic Controversy," Technology and Culture, vol. 22 (Oct. 1981) pp. 700-724. Despite the separation between art and technology, between engineers and architects, however, their interrelationship continued until the early nineteenth century. For example, engineers built mountains in the name of the sublime and the picturesque, and their drawings in the Ecole Poytechnique showed poetic figuration.
116 Ibid.
117 Ibid.

the use of iron in architecture. With its lightness and visual slenderness, the iron bridge clearly offended classical aesthetic norms of stability based on visual solidity. Traditionalists such as Charles François Viel, Huvé and Lussault criticized the iron bridge through architectural journals as "unpleasing and undemocratic, or non-aesthetic" and "Gothic in its lack of substance both in plan and in elevation, with piers no more than two meters wide, allowing for no wearing with time."[118] C.-F. Viel criticized even the use of iron reinforcement in architecture and advocated a return to the classical ideal of monolithic construction in his De la construction des édifices publics sans l'emploi du fer, published in 1803.

After the completion of the Pont des Arts, Napoleon himself was not so confident of the aesthetic quality of the bridge, and asked the opinion of his architect Fontaine. Fontaine, as an architect trained in classical architecture, held the same position as most architects, rejecting the iron bridge as not being solid and lacking *convenance*: He replied:

> . . .la construction d'un pont en fer était une faute de convenance: que cette sorte de bâtisse utilisée à Londres pour des arcs de grandes dimensions était hors de raison à Paris. Car les Anglais n'ont recours a ce moyen que pour suppléer la pierre qui manque à leur sol, et l'on ne peut concevoir pourquoi à Paris, où la pierre est en si grande abondance, on a employé le fer qui coûte plus et qui est moins solide.[119]

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[118] Journal des bâtiments , X III (12 Vendémaire yr. XII) p. 59. Quoted in Hélène Lipstadt, "Early Architectural Periodicals," in The Beaux-Arts and Nineteenth Century French architecture (Cambridge, Mass: MIT Press, 1982) p. 55. In the early nineteenth century, the newly emerged architectural journals played a role as an open forum on debates on art and architecture. While architectural production was rationalized and engineers were gaining more power in the production of architecture, classicists tried to maintain their privilege by confining architecture in the category of art. The architectural journals implicitly presented a position of architecture as art, differentiating it from engineering by emphasizing the aesthetic quality of architecture.

[119] Fontaine, Journal, 18

Napoleon expressed his own dissatisfaction with the iron bridge, based on classical norms of visual solidity:"[the bridge had] no appearance of solidity, . . .nothing of grandiosity."[120]

However, it should be noted that iron was employed as a construction material primarily for the reasons of economy, efficiency and practical need of construction such as fire resistance. Iron construction had no aesthetic significance for the engineers, in the first place; the engineers' concern was in the economics of construction. When Montpetit first proposed the iron bridge in 1779, he emphasized this point in the process of fabrication: "La méchanique, se montant à vis de clavettes, peut être fabliqué en différents lieux éloignés et amené par parties à sa déstination."[121] It was by architects that iron construction entered the world of representation.[122] However, many of the architects who opposed the iron construction were architects who were alienated from government jobs or from the Institute. Government architects such as Percier and Fontain were more flexible on iron construction although they opposed the construction of iron bridges: In fact, insofar as iron was not used for the visible elements of classical architecture, they did not reject its use as a construction material. For example, although Fontaine denounced iron bridges, he later praised the iron roof structure of the Hall au Blé, constructed in 1808. And later, Fontaine himself used iron in the floor and roof structure of the Palais Royale because of the practical needs of the building and built the iron arcade of the Galerie de Palais Royale in 1826.[123]

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120 Louis Antoine Fauvelet de Bourrienne, Mémoires of Napoléon Bonaparte, quoted in Steiner, "Building with Iron: Napoleonic Controversy," p. 713

121 Montpetit, "Calcule sommaire du prix d'une arche en fer de 20 pieds d'ouverture et de 40 pieds de large proposé à l'Académie des Sciences" in Encyclopédie méthodique, article "Fer," pp. 639-642. Quoted in Lemoine, L'Architecture du fer, p. 98

122 Hélène Lipstadt pointed out the remarkable silence from engineers side to architects' criticism. See Hélène Lipstadt, Architecte et ingénieur dans la presse and "Early Architectural Periodicals," in The Beaux-Arts and nineteenth century French architecture, ed, by Robin Middleton (Cambridge: MIT Press, 1982)

123 Thus architects' polemics in the journals against engineers were just surface phenomena. The real conflict was not between architects and engineers but between architects, as Hélène Lipstadt pointed out. See Hélène Lipstadt, Architecte et ingénieur dans la presse

As it already seems clear in their utilitarian character, the use of iron in such practical constructions in the late eighteenth century had a clear relationship with the emergence of the bourgeoisie. As the bourgeoisie emerged as a new class with a dominant economic power, there was a need for new types of public buildings which would meet new social needs. The transformation of the Louvre into the public museum was in fact an attempt to meet the new social changes, which had been requested since the late eighteenth century by enlightenment philosophers such as Diderot and Voltaire.[124] The Louvre thus became a symbol of secular power of the emerging bourgeois class as opposed to the political and religious power of nobility and the church in the previous age. As an industrial material, iron was also associated with the bourgeois class from the outset. Therefore, it was not by chance that iron was first employed in those buildings which represented the emergence of bourgeois public space such as public galleries and theaters. In the nineteenth century, iron became a symbol of a new economic and social status for the bourgeoisie and engineers. Therefore, when the first iron bridge was constructed, it was identified by architects with the bourgeois quest for profit, built with the help of engineers.[125] C.-F. Viel criticized the Pont des Arts as "gothique. . .conception barbare" and "objet de spéculation financière qui aurait pu être construit mieux, par architecte."[126] And F.C.L.B. wrote: "la spéculation l'a emporté sur le goût et ceux qui dirigeaient les travaux ont été forcés aussi de céder à l'intérêt des actionnaires."[127]

After the completion of Ponts des Art in 1803, several other iron bridges were constructed in the following years, which adapted the methods of either timber or stone construction. The Pont d'Austerlitz, which adapted the voussoir principle of stone construction, was completed by engineer Lamenadé, supervised by Becquey-Beaupré in

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124 For an excellent analysis of the relationship between the salon of the Louvre and Bourgeois public space, see Thomas Crow, Painters and Public Life in Eighteenth Century Paris (New Heaven: Yale Univ. Press, 1985)

125 If fact, the iron bridge was built by a private company in return of prolongment of its exploitation right and under the direction of the engineers of the ponts et Chaussées.

126 Quoted in Hélène Lipstadt, Architecte et ingénieur dans la presse, p. 93

127 Ibid.

1806.(fig. 28) In 1807, Louis Bruyère, the successor of Becquey-Beaupré at the Conseil de Ponts et Chaussées built a wrought iron bridge across the Crould (fig. 29). This first wrought iron bridge was a translation into iron of a form of a timber truss. Between 1809 and 1811, two bridges which were to span the Seine at the Hôtel des Invalides and at the Place d'Iena were under discussion. Emmanuel Crétet, the minister of the Interior between 1806 and 1809, proposed an iron bridge at the Place d'Iena. Bruyère proposed an iron bridge of 114 meters on the axis of the Hôtel des Invalides, based on the same principle as his former bridge. However, with the continuing construction of iron bridges, architects of the Beaux-Arts section of the Institute and Napoleon's architect Fontaine were concerned about the beautification of Paris. Thus, when the Pont des Invalides was proposed, Fontaine opposed it. He wrote to the Emperor: "It will be scarcely accessible to people on foot because of the height that a single arch would require. The frame work of iron would produce a bad effect... I consider this proposition as a folly."[128] Architects considered the iron construction aesthetically inappropriate.

However, gradually iron bridges were received favorably in architectural journals. When the Pont d'Austerlitz was completed in 1806, the contemporaries this time praised the "beauté de ses proportions, la noble simplicité de de son architecture, la magnificence du site."[129] After 1808, in Annales de l'architecture (former Journal des bâtiments), iron bridges became objects of admiration, which inspired surprise by their beauty, and "l'étonnement par légèreté et le filigraine de la serrurerie."[130] The norms of classical architecture were no longer the authority by this time and iron construction seemed to carry the new aesthetic standard of romanticism. However, it should be reminded that, as discussed earlier, iron bridges were constructed in part as a rationalization of transportation

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[128] Quoted in Frances H. Steiner, "Building with Iron: Napoleonic Controversy," p. 715

[129] Cited by Lanzac de Laborie, Paris sous Napoléon, vol. 2. p. 120. Quoted in Bertrand Lemoine, L'Architecture du fer, p. 102.

[130] Lambert de Bilan, "Travaux publics: Embellishments de Paris," Annales de l'architecture, (6 Janvier, 1808) p. 29; L'Iroquois, "Variétés," ibid. (20 décembre 1808) p. 326. Quoted in Hélène Lipstadt, Architecte et ingénieur dans la presse p. 96

systems and territorialization. For the engineers, aesthetic consideration in building the iron bridges was, if any, only secondary. Thus, it was by architects that iron emerged as a material of aesthetic significance. A technological object was invested in the world of representation, but paradoxically in architects' effort to secure their profession by claiming the aesthetic superiority of architecture.[131]

The continuing construction of iron bridges reflected the increasing power of engineers over architects in the construction of public works. In 1806, Émiland Gauthey, the engineer of the Pantheon, wrote a treatise on the construction of bridges Traité de la construction des ponts, which was edited and published by his nephew Navier in 1809 after his death. Gauthey's work discussed almost thirty proposals of iron bridges, including not only French but also English, Belgian and German designs. As Frances Steiner stated "[B]oth the rapidity with which new projects issued forth from French engineers, as well as the variety of their structural solutions reflects a popularity of the concept of iron bridge building which must have come to the attention of the emperor."[132] In 1806, when Napoléon re-established the École des Beaux-Arts as a part of administrative reform, he appointed J.-B. Rondelet, an engineer and the superintendent of the church of Ste.-Geneviève, as the professor of stereotomy. This was the first attempt of the École to deal with structural problems. Rondelet taught "construction" in the École des Beaux-Arts and tried to reform the École further in a more productive direction. The dominance of engineers and their methods in public works during the first Empire culminated in the appointment of Bruyère, an engineer of the École des Ponts et Chaussées, as a director of the Travaux de Paris in 1812 with authority over the Conseil des Bâtiments Civils.

Besides iron bridges, another major achievement of iron construction in the early nineteenth century in France was the dome of the Halle au Blé. Originally constructed by Nicolas Le Camus de Mezières (1721-89) in 1767 as a stone building with an open court in

[131] C.-F. Viel, "Architecture hydraulique," XII (23 fructidor an xi) pp. 370-2
[132] Frances H. Steiner, op. cit., p. 172

the center, the Halle au Blé was much admired by the contemporaries such as Laugier. But critics complained that it stood in too small a place. Soon it was agreed to cover the inner court of 39. 26 diameter which was in constant use. In 1782, two projects were submitted for actual consideration. A proposal for a completely wrought iron-framed roof was submitted by architect François Joseph Bélanger (1744-1831) and Deumier, an Parisian iron contractor. Bélanger had visited England in 1766 and was interested in iron construction which was being developed at that time in England. His idea of using iron as a construction material must have been influenced by his visit to England.[133] However, as discussed earlier, by this time in France, there had already been many proposals for iron bridges and uses of iron as a substitute for wood for practical purposes. However, due to the economic reason of construction cost and time, the building commission rejected Bélanger's proposal and selected a proposal for timber roof designed after the framing technique of Philibert de l'Orme by Jacques G. Legrand (1743-1808) and Jacques Molinos (1750-1831). However, the new dome was completely demolished by fire in 1803.

In 1806, six projects by Rondelet, Mangin, Duvault, Giraud, Bélanger and Legrand were submitted to Crétet, the minister of the Interior, who turned them over to the Conseil de Travaux Public for consideration. Bélanger once again submitted a design of a wrought iron dome. The debates centered around the aesthetic factor, on the one hand, and economic and technical aspects, on the other. Rondelet and Viel, among other members of the commission, insisted on the monumental aesthetic of the dome, preferring stone construction. In 1803, after the fire, Rondelet had published a book with four possible methods of vaulting the Halle au Blé, each based on different materials: brick, stone, timber, and iron.[134] There, Rondelet had preferred stone or brick construction, based on the analysis of their respective construction costs, and concluded that stone would be the most economical material to use. (fig.30) But it was quite possible that unlike his claim,

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133 Jean Stern, A l'ombre de Sophie Arnould: F.-J. Bélanger, (1930)

134 Jean Baptist Rondelet, Mémoire sur la reconstruction de la coupole de la Halle au Blé de Paris,(1803)

Rondelet's conclusion was based on aesthetic criteria. As Dora Wiebenson pointed out in her article, "The Two Domes in Halles aux Blés in Paris," it was a defense of the Pantheon like monumental aesthetic rather than economy of structure that he had chosen.[135] C.-F. Viel was a conservative architect and very critical of using iron in architecture. In 1805, he published L'impuissance des mathématiques pour assurer la solidité de bâtiments , advocating homogeneous construction based on ancient methods of construction. Bélanger, on the other hand, emphasized economic and technical merits of iron, such as solidity, inexpensiveness and lightness. He also held that the iron dome was economical in terms of construction processes. He argued that the existing structure would be enough to support the light dome of iron and that the court could be used even during construction.[136]

After studying the proposals, the Conseil reported that all five were not executable. A new committee composed of members of the Bâtiments Civils and the Conseil des Travaux Publics was formed, and the next year, on February, 1807, selected the stone project. This decision was a reflection of the last stand of traditionalists and their concept of an architectural monument. But Crétet, still dissatisfied, asked the group to consider again the possibility of constructing the dome of iron, apparently based on economic necessity. Then, Crétet finally ordered that the dome which would cover the grain exchange be of iron, in order to avoid a fire such as the one that had destroyed the former roof, as well as to favor a much more economical fabrication of wrought iron.[137] But it is certain that the minister of the Interior was also guided by the reasoning and studies of the architect Bélanger, who, in a letter to the minister, listed the advantages of the material.[138]

In April, 1807, the committee headed by the engineer Becquey de Beaupré, the supervisor of the construction of the Pont d'Austerlitz which was constructed of cast iron

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135 See Dora Wiebenson, "The two Domes in Halles aux Blés in Paris," Art Bulletin, (1973) pp. 262-79.
136 Ibid.
137 Frances. Steiner, "Building with Iron: Napoleonic Controversy," p. 719, Viel noted that the stone dome was estimated at 800000fr. and the iron dome at 600000fr. It is quite contrasting to Rondelet's estimation in 1803. See Viel. Dissertation sur.... (1809)
138 Dora Wiebenson, op. cit., p. 279. Originally in Stern, A l'ombre de Sophie Arnould: F-J Bélanger, (Paris, 1930) P.201, 204-6

voussoirs, issued a report on Bélanger's dome designed in two alternative materials - wrought iron and cast iron. In 1808, Bélanger's project was accepted by the commission, and in 1808 Napoleon finally approved it. The actual construction began in 1809 with cast iron produced at Le Creusot, but the dome was not completed until 1813.(fig. 31, 32) Charles François Viel continued to oppose the iron dome, and criticized it in his Dissertations sur les projets de coupoles de la Halle au Blé de Paris (1809).

After the completion of the Halle au Blé, Napoleon praised it as "magnificent,"[139] and this time, Pierre Fontaine was also more satisfied with this iron construction than he had been before. "This work," he wrote, "is one of the most remarkable which has been erected under the present regime."[140] Bélanger's dome was the largest structure of the time. The novelty of the use of iron and the thinner dimensions made the Halle au Blé a notable attraction throughout the nineteenth century and served as a hint of great technical advances.

Basically, the iron dome of the Halle au Blé was a continuation of the iron roof structure which had been built since the late eighteenth century. Iron roof structures had already been constructed in the skylight of the Louvre and the Théâtre Français by Victor Louis. These early iron constructions were based on the traditional mechanics of timber and stone structures. But in its large scale, the Halle au Blé was the most important achievement which influenced the later use of iron in architecture. In the Halle au Blé, Bélanger adapted Philibert de l'Orme's timber framing system. Bélanger's knowledge of stone construction played an important role as well since he also adapted the *voussoir* principle to the new material of iron as had Lemande in the Pont d'Austerlitz. The iron members were calculated in advance by Brunet, a former contractor and controller of the works of the Halle.[141] However, by that time, there was no major progress in a scientific

139 Jean Stern, l'ombre de Sophie Arnould, François Joseph Bélanger, vol. 2 (Paris, 1930) p. 246

140 Louis Hautecoeur, Histoire de l'architecture classique en France, vol.5 (Paris: Picard, 1950-53) pp. 224-225

141. For the story of the dome, see Stern, A l'ombre de Sophie Arnould: François Joseph Bélanger; Donald D. Schneider, The Works and Doctrine of Jacques Ignace Hittorff (Ph. D. Disser.1970, New York: Garland

understanding of the iron structure. It was only after 1830 that structural mechanics was applied in architectural construction. The emergence of iron construction is thus to be seen as a consequence of the collapse of the classical aesthetic system and the rationalization of architectural practices with a new constructive concept of architecture, rather than as a result of the development of iron construction technology itself.

After the demise of Napoleon in 1815, Quatremère de Quincy, the permanent secretary of the Academy since 1816, tried to restore classical idealism. He denounced the use of iron in architecture, and even criticized the use of the iron reinforced lintel with *voussoirs*. However, iron continued to be used during the Restoration. As I will discuss in chapter four, iron floor and roof framing was employed in major government buildings in order to resist fire; engineers continued to make progress in structural engineering and in the scientific study on the strength of iron; structural and decorative elements of cast iron were also introduced into the market. Cast iron columns and wrought iron tie beams were most popularly used in shops and private buildings. By the 1830s, thus, many new building types of iron construction such as arcades, winter gardens, market hall were built by architects and constructors. Even Fontaine, who had so often disagreed with the Emperor on the subject of iron, designed in 1829 the Galerie d'Orleans in the Palais Royale with an iron and glass roof.

Publication, 1977); And Dora Wiebenson, "The Two dome..." For Brunet's calculation of the iron members, see "Dimensions des fers qui doivent former la coupole de la halle aux graines, calculées pour l'exécution du projet de M. Bélanger, architecte des monuments publics, par F. Brunet, ancien entrepreneur des bâtiments, et contrôleur des travaux de la halle (Paris, 1809)

Chapter Three. Aesthetics vs. Construction: Transformation of Neo-Classical Theories of Architecture and Iron Construction, 1800-1830

The classical theory of architecture projected a comprehensive vision of the world in which works of art and of utility came together; far from competing with each other, there was to be an indissoluble unity between taste and construction, art and industry. The architectural ideal of the eighteenth century Enlightenment was to maintain this unity in architecture during the process of rationalization and the development of science and technology. In neoclassicism, thus, new techniques of construction and a scientific understanding of material and structural mechanics were to be in harmony with a comprehensive system of architectural theory. Consequently, J.- F. Blondel, a representative theorist of eighteenth century neoclassicism, considered construction an important part of his architectural theory along with decoration and distribution (planning) - even though he paid little attention to construction. As discusses in the previous chapter, Pierre Patte also attempted to reorganize architectural knowledge by making an exhaustive compilation of construction technology. However, as engineering approaches advanced in the late eighteenth century, structural questions gradually separated from architectural theory. Although Blondel tried to reintegrate them by establishing a relationship between detail and distribution through the concept of *convenance*, the concept of structure that the architect had was already anachronistic in the development of modern sciences based on modern methods of mathematical calculation and a dynamic concept of structure.[142]

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[142] For a detailed analysis of Blondel's theory, See Antoine Picon, French Architects and Engineers in the Age of Enlightenment, translated by Martin Thom (Cambridge: Cambridge Univ. Press, 1992)

By the end of the eighteenth century, the rationalist theory of neoclassical architecture had lost its ability to reconcile architecture and engineering. Engineers' discourses based on technological rationality had become more and more independent from architectural theory. In the engineering approach to architectural production, social utility and economy of material were emphasized over formal coherence of architectural expression, i. e. *convenance*. Altogether, it seemed impossible any more for architectural theory to control both technology and aesthetics at the same time.[143] In the split between economy and culture, between engineering and the classical concept of art, the domain of architecture was inevitably separated into *art* and *science of construction*.

In the fragmentation of the neoclassical theory of architecture, iron construction emerged as a symbolic object. It signified all that was not classical; for example, the practical approach to architecture by engineers as opposed to the formal approach of traditional classical architects; lightness of structure against the visual solidity of stone structure, and ultimately the separation of technological knowledge from architectural theory. Thus, when iron construction emerged at the beginning of the nineteenth century, iron construction quickly became a center of controversy engendered by the conservative architects who still held a strong belief in the traditional classical aesthetic canons as we have seen in the previous chapter.

However, it was not simply a nostalgic conservatism that was prevalent in architectural theories at the turn of the century. In the crisis of neoclassicism, there were also continuous efforts to renew the classical theory in order to regain the lost ground. This transformation of neoclassical theory was carried out by disciples of J.-F. Blondel such as Boullée, Ledoux, and later Durand and Rondelet. Since it was already impossible for architectural theory to control technology and aesthetics simultaneously, it was inevitable that the renewed theories of neoclassicism would be concerned with defining the

[143] This can be proved by the transformation of the concept and the role of details in architecture in the late eighteenth century as Picon analyzed in his book. Details which played a connecting role between structure and architectural theory fragmented and came to signify decoration dissociated from structural considerations. See ibid., p. 286-299

discipline of architecture as either art or construction and with knowledge within the discipline. Thus, in the early nineteenth century, one witnessed the separation of neoclassical theory of architecture into the pure aestheticism of Boullée and Ledoux, and the utilitarianism of Durand and Rondelet. This section is a general survey of the transformation of neoclassical theory since the late eighteenth century in the aftermath of the crisis of classical theory.

Boullée and Ledoux tried to renew classical architecture through the elaboration of the theory of "character" by inventing new formal languages of architecture; here the domain of construction was only of secondary interest. On the other hand, with an independent notion of structure based on techniques of handling material and mechanical understanding of it, *l'art de bâtir* became an independent object of architectural theory with Durand and Rondelet. Although the renewed neoclassical theories, whether based on aesthetics or construction, tried to resolve the problem of classical theory by assimilating engineering principles to the theories, they were not yet able to conceive of iron construction as a distinctive new genre of architecture. However, Durand and Rondelet's neoclassical theories contributed significantly to the development of iron construction in the middle of the century by providing a constructive and structural concept of architecture based on utility and economy of construction.

By the time Blondel completed his Cours d'architecture in the early 1770s, his effort to make a coherent formal system of architecture which corresponds to the social hierarchy already proved ineffective and ultimately a failure. In the transformation of the hierarchical system of the society which was caused by the emergence of a new bourgeois class and in the needs for new building types for the new emerging class, Blondel's Cours finally provided nothing better than a boundless list of characters without any consistency.[144] The demands of the new rich clients for some representation of their hard-won status supported the emerging taste for aesthetic criteria based on the effect of forms

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[144] See Anthony Vidler, "Idea of Type," Oppositions 8 (1977) pp. 95-133

on the sensations rather than on the absolute norms of proportions or beauty.[145] Moreover, with scientific archeological studies of classical remains from the mid-eighteenth century on, both nature and the consistency of antique precedents had lost their authority, and the gap between theory and practice had widened. After the death of Blondel in 1774, his pupils felt they were without a proper theoretical foundation.[146]

Boullée and Ledoux, as disciples of Blondel, inherited his theory of character. But, they already recognized the limit of the classical vocabularies of architecture in relating architecture to the society of the late eighteenth century. Thus, despite Blondel's criticism, they chose to invent a more comprehensive system of architectural language which could link architecture and society in a more fundamental way. They believed that this could be done by discovering what they believed to be the truth of architecture, that is, a natural basis of architecture. The search for the natural origin of architecture was not new. It had already been explored by Abbé Laugier in the mid-eighteenth century. Against the tabula rasa tendency of architectural styles, Laugier proposed a model of the primitive hut derived from the natural state of building industry.(fig. 6) However, as discussed in the previous chapter, Laugier's ideal model of the primitive hut, which was originally conceived as a constructive model that reconciled structural logic and classical taste, was able to be realized only through the techniques of iron reinforcement, which was unnatural and indirect. This idea of nature as a *répertoire* of a constructive architectural form was thus breached by the structural rationality which already had begun to take an independent course.[147]

To Boullée and Ledoux, nature was still an absolute point of reference for architecture, and architecture was to be an art based on the imitation of nature. If nature did not provide a concrete model for the architectural type, it was then necessary for them to revise the concept of nature along with the concept of imitation. At this point, Boullée and

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145 Anthony Vidler, Claude-Nicolas Ledoux (Cambridge: MIT Press, 1990) p. 20
146 Antoine Picon, op. cit., Chapter 10, pp. 256-334
147 Rondelet later answered Laugier in his Traité... by expounding diversity of actual building methods that were linked to local materials and climates.

Ledoux were strongly influenced by the concept of nature recently advanced by modern science, according to which nature was not a *répertoire* of forms but a mysterious entity whose regularity is to be discovered by a man. The failure of Laugier's theory was then due to his faulty analogy which revealed his misunderstanding of the imitation of nature. According to the new concept of nature, it was nature's law of creation, not the object nature created, that should be imitated. Boullée and Ledoux turned to the simple geometrical forms of architecture such as the cube and the sphere, which had been developed in the rationalization of space since the mid-eighteenth century. These simple geometries were associated with the then popular theory of sensation. In the mid-eighteenth century, architecture was basically conceived as a language whose expression depended on sensations. Architectural theory's interest in the sensations of spectators during the mid- eighteenth century was itself a subjective tendency in the classical theory; i.e., as architects gradually recognized the shaky ground of the traditional notion of stability, they became more interested in the subjective sensations that architectural forms give to spectators, rather than in construction itself. In fact, it was in this context that Blondel invented his theory of character.[148] But, while the notion of character failed as a communicative channel between architecture and society, the theory of sensation of architectural forms adapted by the revolutionary architects went to the extreme of trying to manipulate sensations as rigorously as engineers controlled physical factors.[149]

Boullée and Ledoux believed in the existence of nature which is ruled by the laws of sensations. In Architecture, Essai sur art, published in 1803, Boullée argued that there is a rational correspondence between simple geometry and sensation. For him, simple geometries have almost allegorical meanings. The architectural utopia of Boullée was therefore to create an architecture which ". . . intended to make the design speak prior to language and to combine with society through the expression of an essence as primitive as

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[148] This was why there was gradual disinterest in stereotomy during the latter part of the eighteenth century.

[149] For this matter, engineers held the same position. There was no distinction between sensation and calculation until the early nineteenth century. See Antoine Picon, op. cit.

the needs."[150] This neoclassical utopia of geometrical forms was, as Vidler accurately pointed out, "...a vain but powerful movement to reconstitute a symbolic universe reminiscent of the Golden Age."[151] Vidler continued: "In their work [Boullée and Ledoux], the amalgam of type as origins, type as characteristic form of a classified species, and type as symbolic mark was held together, perhaps for the last time."[152]

This transformation of the concept of nature from a repertoire of form to a principle marks a very important point in the transition from rationalist architects of the enlightenment such as Soufflot to the revolutionary architects of the turn of the century. Changed here was the role of architects. For the revolutionary architects, the role of architects and artists was to find the order and rules in nature and to make them explicit. Thus, an artist was given a status of a genius, who, in his creation, follows the natural laws rather than violating them. This concept of an artist as genius made it possible temporarily to reconcile the long standing dilemma of neoclassicism between necessity of rules and freedom of aesthetic invention. Thanks to the concept of architect as genius, architecture now became a creative art and at the same time the imitation of the natural laws.

For the revolutionary architects, the principle of architecture was design. According to Boullée, architecture can raise sensations in the minds of spectators through design. It is logical then that Boullée defined architecture as a creation of mind with construction being only a means to achieve it. Boullée wrote in the preface of Architecture, Essai sur l'art:

> What is architecture? Shall I follow Vitruvius in defining it as the art of building? No. This definition rests on a crude error. Vitruvius mistook the effect for the cause. One must conceive if one is to put something into effect. Our ancestors only built their huts when they had conceived the image of them. It is this production of the mind, this creation which

150 Antoine Picon, op. cit.
151 Anthony Vidler, "Idea of Type," Oppositions 8 (1977) p. 102
152 Ibid.

> constitutes architecture, and which can consequently to be defined as the art of designing and bringing to perfection any building whatsoever. Thus, the art of construction is merely an auxiliary art which, in our opinion, could appropriately be called the scientific side of architecture.[153]

By differentiating architecture from the art of construction, whose essence is the sensation of beauty which resulted from imitating nature, Boullée took it upon himself to define the principles of sensation in nature as rigorously as possible. The principle of beauty, according to Boullée, is not a pure fantasy or an invention having nothing to do with nature as Perrault had argued a century before, but is as scientific as the principles in nature. He argued that these principles of architectural form had simply been ignored until then by the authors of architectural treatises. Thus he wrote in conclusion: "... I am trying to answer that what I undertand by art is everything that aims at imitating nature; that no artchitect has attempted the task I have undertaken;"[154]

While Boullée's works championed the poetics of architecture, most of which were based on academic and imaginary projects, Ledoux' s architecture was more practical and aimed at reforming the existing social order. Ledoux tried to develop a symbolic mode that would respond to the emergent forms of social and industrial production. Yet, in defining architecture as "design," he was not totally different from Boullée. In his L'architecture published in 1804, Ledoux put forward the same line of argument as Boullée, claiming that an architect should be a painter to be a good architect.[155]

Despite their exclusive interest in formal language, however, one can easily detect a strong affinity between the revolutionary architects' neoclassical theories and the engineers' approach. The revolutionary architects' preoccupation with nature as an active and universal entity which could be converted to a logic of utility and economy is equivalent to

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153 Etienne-Louis Boullée, "Introduction," Architecture, Essai sur l'art, translated by Sheila de Vallée
154 Ibid.
155 Ledoux, L'architecture (Paris, 1804) p. 113: "If you wish to become an architect, begin by being a painter."

technicians' attitudes to nature. In its operation as well, the accuracy of engineering calculation is matched by the accuracy of sensation which architects evoke through their genius. In a sense, it was almost like a projection of a paradigm of machine into the psyche. They even registered the sensation of sublime which Blondel denounced as pertaining to the buildings of engineers. In fact, their concept of architects as genius and their theory of sensation of geometrical forms were an attempt to make a conceptual framework that would make mechanization and aestheticization compatible. As Picon stated, ". . .between the revolutionary design and the notion of structural model, there were numerous *rapprochements*; ideal of process, effect of surprise, both calculation and sensation have immediacy in their effect. . . what they [the revolutionary architects] intended in so doing was to transform itself to an effective auxiliary to development."[156] It is therefore not surprising that their neoclassicism quickly became a style engineers used for civic architecture of the post revolutionary society, which required new programs and rationality. Durand, Bruyère and Mandar's treatises, for example, were the proof of engineers' loyalty to neoclassicism until the 1830s.

Although the revolutionary architects tried to resolve the crisis of the classical theory by adapting engineering principles to their formal theories of architecture, it was an ambiguous compromise between the freedom of artistic invention and the need to rationalize architectural production. As Anthony Vidler pointed out, in theories of architecture of Boullée and Ledoux,". . . there was an inherent conflict between the idea of type and idea of character, a conflict centered on the problem of individuality."[157] The ambiguity of the neoclassicism ultimately led to an explosion of individuality which conflicted with the need for rationalization. Thus they were criticized by orthodox classicists such as C.- F. Viel and Quatremère de Quincy, the future academician. As Vidler stated, "Boullée and Ledoux in elevating character to a primary formative role and in postulating the endless play of abstract geometrical permutation as its instrument were

[156] Antoine Picon, op. cit., p. 304
[157] Anthony Vidler, op. cit., p. 103

undermining a truly rational system of types."[158] Their projects were thus no longer possible except in utopia. In reality, there was a gap between art and technology, which could not be overcome by this brand of formal assimilation. While the architects were holding to a "dynamics of architectural form," engineers were pioneering structural mechanics based on "dynamics of mathematical formalism". The architectural formalism of the revolutionary architects and their spatial approach thus appeared nonsensical in the rationalization of architectural production. Ledoux's design of a bridge over the Loüe clearly demonstrated the limitation of the formal approach to the problem of controlling technology by art. In his bridge, Ledoux adapted Perronet's new technical model of the long span bridge construction and tried to make an aesthetic correction for the engineering. However, the resultant design was really a stone boat.[159] (fig. 33) Picon accurately analyzed the inherent problem of the revolutionary architects' formal and spatial approach:

> If the limit of the classical theory which Blondel had reinvoked arose from the impossibility of achieving a correspondence, through a systematic designation of the principles and parts of the arts, between architecture and society, the limits of revolutionary architecture were inherent in architectural space itself. . . . .
>
> The revolutionary architects sought to make architecture 'speak' prior to language, while at the same time claiming to calculate, without having recourse to mathematics, . . . The loophole therefore lay in a poetics based on the desire for a non mathematical accuracy, both of which were altogether impossible. This poetics was based on the implicit recognition of threatening rationalities of exact science, which constitutes the real limits to the architectural approach. . . The relationship of revolutionary architecture to the engineers system, though very close at the time, turned out to be particularly ambiguous. . . . The hegemonic will of the revolutionary architect could only with great difficulty mask the demands for rationality which had been imposed on them. The ambiguities of design were also those of an architectural discipline confronted with a more and more

158 Ibid.
159 See Picon, op. cit., p.309

> demanding programming, with a will to anticipate which reflect major advances in the chronological rationality. . . Being caught between the language of programming, flanked by an emergent art history, and the salient calculations of the engineers, could a specifically architectural space still claim to run society and its interchanges? [160]

Picon thus concluded:

> The collapse of classical theory derived from its inability to embody this rationalization. . . Neo-classicism undeniably offered the basis for a solution, by arriving at an accommodation with technological determinations to such an extent that it transformed itself into an effective auxiliary to development. But this attitude remained ambiguous one, inasmuch as architecture claimed at the same time artistic character, reinterpreting productive rules of the modern scientific world in such a way as to further an original and always unusual form of expression. The tension which was thereby created between the certainties of the science of building and a history of the art, which was structured by other imperatives altogether, undoubtedly furnished one of the founding experiences of architectural modernity, a widespread malaise at the start which was gradually to spread.[161]

Traditionalist architects tried to downplay their architecture's contradictory relationship to rationalization and to defend the concept of architecture as art as opposed to the science of construction. They brought up such concepts as artistic disinterest, spirutual value, and artistic genius through architectural journals.[162] However, even to claim architecture as a pure art was contradictory, because, as Hélène Lipstadt pointed out,

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[160] Ibid., pp. 309-311

[161] Ibid., p. 339.

[162] In the early nineteenth century (1800-1815) architectural journals first appeared. The role of the journals was as an open forum on the issue of the relatioship among art, architecture and engineering, which has been going through tremendous transformation at that time. Journals implicitly presented a position of architecture as art differentiating it from engineers by emphasizing the aesthetic quality of architecture. Graphic representation was assured means to give architecture the status of arts since the Renaissance. In the 1800s architectural journals began to reproduce graphic representation.

architects ultimately depended on the client for the realization of their works. In order to be an autonomous artist with disinterest, who is compensated only by a spiritual value as they argued, an architect had to be able to control his production. However, public perception of architecture was as an art of building and beyond that, there was no way to claim that one was an architect.[163] Boullée himself recognized this dilemma and regretted it in the introduction to the l'Architecture, l'essai sur l'art;

> . . .how preferable is the fate of painters and men of letters? They are free and independent. They can choose their subjects and follow the bent of their genius. Their reputation depends on no one but themselves. . . These are the incomparable joys and incalculable advantages of which a young architect is deprived for his talent would remain buried if he devoted all his time to study.[164]

While Boullée and Ledoux were interested in elaborating formal languages beyond the norms of classical architecture, as for the techniques of construction, they were, rather, faithful to the natural limit of the material and the traditional methods of construction. When one considers their devotion to the fundamental relationship between architecture and nature, this was quite natural. Their position seems quite opposite to Laugier's model of the primitive hut, which was conceived as a model derived from nature, but could be realized by unnatural methods of iron reinforcement. Boullée and Ledoux rejected the absolute norms of the classical architecture developed by the previous generation and went on to invent new formal languages; in terms of construction, however, they rather relied on materials that nature provided, the traditional methods of homogeneous construction and the traditional concept of visual and geometrical solidity. In light of this, an anonymous

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163 Hélène Lipstadt, Architecte et Ingénieur dans la Presse (Paris: CORDA IERAU, Ministere de l'Environment, 1980) However, it seems hard to agree that the major adversaries of architects during the 1800s were artisans as Hélène Lipstadt argued. I believe that they were rather engineers. She seemed to have disregarded historical conditions of the nineteenth century.

164 Boullée, op. cit.

reviewer of Ledoux's L'architecture gave a fairly accurate account of Ledoux's architecture. He wrote:

> Ledoux, who principally looked for effect with regard to the ordering of the buildings and for solidity in their construction, was .., obliged to depart from the received principles of the ancients. Firstly, because they did not offer the necessary resources for an imagination as ardent as his own, . . . secondly, because our land produces no materials of the grandeur and strength equal to those of the marbles from the quarries of Greece and Italy, he was obliged to search for forms, lines, and new sections in order to obtain, with stones of small dimension, and without the use of iron, the solidity that the ancients achieved with enormous mass. One could say that he endowed his very forms with the imprint of a creative genius.[165]

When the limitation of revolutionary architects' attempt to resolve the crisis of classical architecture by adapting engineering principles to the world of formal representation became clear, it was inevitable to revise the definition of architectural discipline from a formal aesthetic to a technological one. This was the approach taken by J.-N.-L. Durand and Rondelet. Contrary to Boullée and Ledoux, Durand and Rondelet denounced the formal and linguistic solutions to the problems of architecture and focused instead on the principles of construction and their rationalization. Rejecting the hitherto unchallenged view that the fundamental objective of architecture is to give pleasure to spectators through the imitation of nature, they defined the discipline of architecture in terms of utility and construction. For them, nature ceased to be the model to be imitated. Thus, they rejected both the Vitruvian explanation of the origin of the orders of classical architecture and Laugier's model of the primitive hut. They even went as far as to reject architecture's link to nature altogether.

165' "M," Review of Ledoux's L'architecture in Annales des bâtiments 3 (1818) 238-34. Quoted in Anthony Vidler, Claude-Nicolas Ledoux (Cambridge: MIT Press, 1990) p. 96

In his earlier career, Durand, as a disciple of Boullée, shared the revolutionary architects' project of the characterization of every building type, believing in the correspondence between the expression of geometrical forms and the sensation in nature. However, Durand was also a student of Perronet, the engineer of the École des Ponts et Chaussées, and by his request Durand became Professor of architecture at the École Polytechnique in 1797, taking Baltard's position. In 1802, on the publication of the Précis des leçons d'architecture données à l'École Polytechnique, (1802-5, reprinted until 1840), Durand changed his position on the true principles of architecture; by this time, Durand came to recognize that the characterization of every building type through formal expression was an impossible task and even a contradictory one in the rapidly changing conditions of society and in the process of rationalization of architectural production. In his Précis des leçons d'architecture données à l'École Polytechnique, Durand wrote:

> Without doubt, the grandeur, magnificence, verity, the effect and the character that one notices in the buildings are so many beauties, so many causes of pleasure that we feel at the sight of them. But where is the need to run after all of that? If one disposes a building in a way that is suitable for its use, will it not be obviously different from another building intended for another use? Will it not naturally have a character, and, what is more, its own character? [166]

Thus he denounced the theory of character based on the visual sensation altogether, and argued that character and beauty of architecture is derived from economy and comfort rather than any geometrical form. By defining architecture in such a way, Durand brought a real break in the classical tradition of representation in architecture; all previous concepts of architecture were to be discarded since they were simply related to the pleasure of sensation. For Durand, the taste of beauty in architecture was like a convention as Perrault had argued in the seventeenth century.

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[166] Jacques-Nicholas-Louis Durand, Précis des Leçons d'architecture (Paris, 1802-5)1:19

Durand believed that architecture's prime objectives were utility and economy. In the preface of the Précis des leçons d'architecture données à l'École Polytechnique, Durand rejected the idea that architecture is an imitation of nature, and defined architecture as "an art of composing and executing all public and private buildings on utility and economy."[167]

In his book, Durand decomposed architecture into materials and the simplest elements like wall and column, and then into more complex parts like porches, vestibules and staircases. He then developed a method of composing these standardized architectural elements on grid sections, directed and organized by axes. This method of composition was, above all, to conceive a plan. An elevation was deduced from the plan by some rules, and then, the section was derived from the plan and the elevation. These three were to be drawn on the same plane and with the same scale so that it was possible to design a building easily according to its function and class.(figs. 34, 35) Durand's method was an attempt to make a comprehensive synthetic grammar of an architectural language, and thus to give a range of examples for various buildings and to classify them into functional types.

In this regard, Durand's neoclassical theory was the most realistic response to architecture's subordination to the engineering principles and the process of rationalization. Indeed, Durand's architectural theory was conceived as a method to teach architecture to engineers in a relatively short time, and was after all an adaptation of the engineer's system. Durand's method had an affinity with Monge's descriptive geometry which was then so popular in the Ecole Polytechnique. Both were represented in a neutral, depersonalized grid space in which an element's position was determined by its relation to others.

However, strangely enough, in Durand's architectural theory, there was a conspicuous absence of the discussion of construction. As for construction in the strict sense, Durand mentioned only generalities and referred his students to Rondelet's book, L'art de bâtir published in 1802. In other words, Durand was interested in distribution

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167 Ibid.

(planning) of architecture rather than construction. It is not surprising then that, in spite of the construction of the Pont des Art in 1803 by Cessart and Dillon, and of the Pont d'Austerlitz in 1804 by Becquey de Beaupré, Durand did not even mention the new possibility of iron construction. Durand's comments on the qualities of the materials in his book between 1802 and 1813 were simply explanatory notes, drawing much information from the works of Pierre Patte. Thus, it is possible to say that despite the adaptation of engineering principles, Durand's approach was still predominantly spatial, if not formal, like those of Boullée and Ledoux. But, as Picon writes, "while Boullée and Ledoux were seeking to turn architectural space into a tool for the dynamic resolution of conflicts engendered by society, Durand resigned himself to playing an auxiliary role to planning."[168]

In this regard, it could be argued that Durand's architectural theory was a continuation of the Enlightenment project which had been continued since Blondel to maintain rationalization and technology within the universal order. The only difference between them was the method of the classification and the principles of the composition. While eighteenth century architects tried to give an order to nature through formal classification, by the end of the century, the new taxonomy had evolved based not on the formal character, but on either structure or function. Natural order was transformed to abstract organization. Monge's descriptive geometry, Cuvier's taxonomy and Durand's architectural theory were all aspects of the desire to give meaning to a process of rational planning by classification. It is at this point that one can see Durand's dual modality; on the one hand he was in the continuous tradition of the Enlightenment rationalist project; on the other, he brought a real break with the classical past by a radical new definition of architecture. This provided a way for post classical eclecticism and for the development of other utilitarian building types, thus making a rupture between the eighteenth century and 1830s neoclassicism.

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[168] Antoine Picon, op. cit., p. 328

Without the interest in construction, however, Durand's architectural theory had a clear limitation in terms of the development of iron construction. Yet, by providing the method to freely compose architecture with standardized elements according to the programs and functions of the building, he contributed significantly to the future development of iron construction. Vidler writes in his article "Idea of type":

> . . . the final effect of Durand's system was to introduce. . .the concept of historicity into architecture. . . neo classicists, Gothicists, and new materialist architects alike could have derived their planning method from Durand's book. . . The grid also allowed for the abstraction and standardization critical for the development of cast iron construction in architecture. Out of Durand were born the forms of the arcades, exhibition halls and railway stations of the mid-century as well as the public monuments of a hegemonic bourgeoisie.[169]

During the nineteenth century, the age of iron construction, one would see the impact of Durand's principles and his method of composition. His theory provided a model of composing functional and utilitarian buildings of iron construction for his disciples such as Reynaud and others. For example, a Belgian engineer, A. Delaveleye cited Durand's principles in order to set equal distances in the supports of an iron building in the 1843 Revue général de l'architecture.[170]

While Durand tried to overcome the limitation of the formal approach of the revolutionary architects by adapting engineering principles to architectural composition, Jean Baptist Rondelet was more radical in defining the discipline of architecture. Rondelet, the superintendent of the church of Ste. Geneviève, criticized architects' and authors' exclusive interest in form and proportions since the Renaissance. In his book, Traité

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[169]Anthony Vidler, "Idea of Type," Oppositions 8 (1977) p. 108

[170] A. Delaveleye, "Des construction en métal," Revue générale de l'architecture (1843) col. 402, 409-410. Werner Szambien also made this point, Jean-Nicholas-Louis Durand (1760-1834) (Paris: Picard, 1984) p.98.

théorique et pratique de l'art de bâtir, published in 1802, Rondelet, like Durand, denied that architecture is an art of imitating nature. He attributed the backwardness of the *art de bâtir* of the Ancients to the tradition of seeing architecture as an art of imitation:

> C'est à l'idée étrange d'avoir voulu assimiler l'architecture aux arts d'imitation qu'il faut attribuer la longue enfance de l'art de bâtir chez les anciens. Le retard où il se trouva, comparativement aux autre arts, vient. . . de ce qu'après avoir étudié les formes et les proportions sur des modèles de charpente, le goût se trouva fixé avant qu'on eût pu connaître d'autres résultats.[171]

However, unlike Durand, Rondelet defined architecture primarily as an art of construction and a scientific understanding of structure rather than as a composition. Rondelet's constructive concept of architecture clearly came up against the traditional artistic concept of architecture of the Academy and the Ecole des Beaux-Arts. With Rondelet, *l'art de bâtir* became a distinctive subject of architectural treatises as opposed to *l'art de dessin*, and became a main interest among architects after the 1830s.[172] Louis-Auguste Boileau, the inventor of an iron church and an advocator of iron architecture during the mid-nineteenth century, recognized the historical importance of Rondelet's book in his Histoire critique de l'invention en architecture:

> les hommes doués du génie de l'architecture, rebutés de la sterilité de l'ésthétique qui preside à la composition, se soint rabattus sur la mécanique de l'exécution, que les acquisitions croissantes de la science pouvaient encore féconder, et que l'art proprement dit ait éte abandonné par eux pour la recherche du perfectionnement de la construction. L'ouvrage remarquable que le célèbre architecte J. Rondelet, a consacré exclusivement à l'art de bâtir restera comme une preuve éclatante de l'amoindrissement que

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171 J.-B. Rondelet, Traité théorique et pratique de l'art de bâtir (Paris, 1802) p. 310

172 For example, Charles Eck published Traité de construction en potérie...(Paris: Blosse, 1836-41) In the preface, he explicitly mentioned that the motivation for the publication of his book was architects' interest in art de batir.

la nullité de l'enseignement des Beaux-Arts a infligé, dans ce dernier temps, aux hommes de la spécialité qui paraissaient appelés, par leurs qualités brillantes, à perdre l'initiative de la régénération de l'art monumental." [173]

Boileau continued, "Cet ouvrage, expression d'une époque qui avait complétement perdu le sens de l'art liberal et l'avait répudie au profit de la science qu'on formulait de toute part, est une oeuvre historique et didactique sur la construction."[174]

The first comprehensive book on the *art de bâtir*, Rondelet's book included extensive attention to iron, recognizing it as an important material in the progress of *l'art de bâtir.* He even performed experiments on the bending of iron, the results of which he published in tabular form in one volume of his book. He also covered the whole range of iron construction, from iron reinforcement of columns, lintels to iron floor and roof systems which had been constructed by that time. However, Rondelet did not yet have a clear idea of the role of iron for future architecture. While he praised the merits of iron as a building material such as its strength and lightness, he expressed reservations about the use of iron in architecture, saying that " Il faut cependent n'employer le fer que losque la necessité les rend indespensable, et leur donner les dispositions, les formes et les dimensions convenables."[175] In fact, in 1808, Rondelet proposed a masonry dome for the Hall au Blé, opposing the use of iron. Rondelet's theory of architecture, thus, despite Boileau's laudatory comments, was not yet able to conceive iron as a new material for future architecture. While he freed architectural discipline from "*art libéral,*" his architectural idea was still dominated by classical taste. It is then not so surprising that the chapter on iron construction in his book, especially the section on the iron reinforcement of lintels, was almost a copy of Patte's book, Mémoires sur les objets les plus importants de l'architecture published decades earlier. In the later edition, he included iron bridges

[173] Louis-Auguste Boileau, Histoire critique de l'invention en architecture, (Paris, 1886) p. 6
[174] Ibid., p. 12
[175] Rondelet, op. cit., vol. 3, p. 197

constructed by engineers and the iron dome by Bélanger. However, he argued extensively that iron was not appropriate for the dome of the Halle au Blé. His idea of architecture was still based on the neoclassical ideal. His proposal for the Halle au Blé in 1803, which I discussed in the previous chapter, clearly demonstrated his aesthetic preference for classical architecture. Rondelet was also critical of the cast iron columns and decorative elements used in commercial architecture during the 1820s as an abuse and urged a more rational solution to iron construction.[176]

Rondelet's Traité was, thus, basically a catalogue of techniques of architectural construction as had been attempted by Patte decades earlier. It was an effort to bring order to the rationalized world of science and technology, which had been the goal of the Enlightenment project. It seems that, for Rondelet, neoclassical norms still served as a frame to maintain the cohernecy of the system. Thus, the possibility of iron construction was examined only within the limits of the received neoclassical norms. But, by defining the discipline of architecture as the science of construction as opposed to the art of design, Rondelet's theory paved the way for the future development of a rational form of iron construction, as Boileau argued. Rondelet's constructive concept of architecture clearly brought architects' attention to material and construction techniques as important parts of architectural education and profession.

After the 1789 Revolution, Rondelet tried to institutionalize his view of architecture. Shortly after the Revolution, in the 1793 Convention, Rondelet argued for the creation of a new more practically oriented architectural school. His role was crucial in the creation of the Ecole Polytechnique in 1794. He also tried to reform the École des Beaux-Art to a more constructive direction. Rondelet's effort took effect in 1806, and he himself became the professor of stereotomy of the new École d'Architecture. This was the first time in history that technological education was conducted in the École des Beaux-Arts. In 1812, Rondelet, together with Laborde, proposed a further transformation of the Ecole

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176 Ibid.

d'Architecture to Ecole des Beaux-Arts with a view to training more practical and efficient government architects. In their proposal, the role of the Beaux-Arts section of the Institute in the Ecole was limited to the writing of the program for the Grand-Prix. Although this reform plan was not carried through, Rondelet's constructive concept of architecture continued to exert a great influence throughout the first half of the nineteenth century. Rondelet's Traité, first published in 1803, was reproduced several times until the mid-nineteenth century and used by the Ecole students as an important text. Rondelet's practical approach to architecture was spread also through the Conseil des Bâtiments Civils, of which he was a member.

While architectural production was rationalized by the state engineers and the Bâtiments Civils during the early nineteenth century, classical architects tried to defend the concept of architecture as art as opposed to a science of construction. Their efforts were an attempt to save art as it faced annihilation in the new industrial and commercialized bourgeois world. The most prominent protagonist of the traditionalist position was Quatremère de Quincy.

Already in the late eighteenth century, Quatremère de Quincy, as *commissaire des arts* during the Revolution, controlled the art world. As a firm classicist, Quatremère de Quincy had a concept of art which was based on idealism, neoplatonism and elitism, and opposed contemporary eclecticism and commercialism. For him, artistic taste belonged exclusively to the elite. Thus, he was hostile to the democratization of pleasure by salons and exhibition.[177] As for architecture, Quatremère opposed both the aesthetic and utilitarian approaches of neoclassicism and advocated a return to orthodox classicism. He was highly critical of the fragmentation of architecture into art and construction. Since he regarded this separation as being encouraged by the establishment of distinct educational institutions of architecture, Quatremère argued against the establishment of the architecture

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[177] See Hélène Lipstadt, op. cit., pp. 58-60

school proposed by Rondelet in his Considérations sur les art du dessin (1791). He complained:

> Who would believe that there exist in Paris two architectural schools distinct in terms of locale, faculty, and curriculum? That one presents architecture as an art of taste and the other presents architecture as an art of need;... That there is a school that teaches how to make a temple and another that teaches how to make bridge? . . . This dismemberment of education has mortally wounded both sides by decomposing the art's essence. It has habituated one group to believe that taste dispenses with solidity and the other to believe that calculations can replace spirit.[178]

Thus, Quatremère de Quincy was critical of the emerging engineering approach and industrialism in architecture by engineers and architects such as Soufflot and Rondelet. In 1791, in the wake of controversy over the church of Ste-Geneviève, Quatremère de Quincy criticized the scientific approach to architecture, arguing that the scientific approach had caused only the separation of art and engineering in architecture and industrialism by depending on calculation. The resultant buildings by engineers, he argued, lacked taste.[179]

True to his idealism, Quatremère de Quincy also criticized Durand's practical approach. Although he acknowledged the usefulness of Durand's architectural theory, he firmly denied the role of such theory in architecture and argued that architecture cannot be taught. For Quatremère, beauty belongs to sense, feeling and impression rather than theory. He was of the opinion that the sentiment of beauty and truth is incomprehensible. Thus, the talent of imitating nature depends on neither education nor the school: "Ce n'est pas toujours dans les écoles que l'on apprend à étudier la nature, c'est encore moins dans les livres. . . les impressions sont supérieures à toutes les leçons de théorie."[180] Quatremère opposed Durand's method of teaching architecture at the Ecole Polytechnique.

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178 Quatremère de Quincy, Considérations sur les arts du dessin (1791) pp. 93-94
179 Hélène Lipstadt, op. cit.
180 Ibid.

In criticizing Durand's approach to architecture, he cynically pointed out its conflict with the artistic principle of invention and creation which he believed was most important in architecture:

> Si la connaissance des arts ne dépendait que des procédés qui s'enseignent et s'apprennent par la pratique, ou la mémoire; on ne les verrait pas dégénérer chaque jour au milieu de ces mêmes écoles instituées pour leur progès, et tant de médiocres sujets ne sortiraient pas de la classe d'un bon professeur.[181]

Quatremère de Quincy was equally critical of the romantic individualism of Ledoux and Boullée. In his Encyclopédie (1788-1825) Quatremère had denounced the play of form in their neoclassical architecture as an abuse of the classical principles. Under the heading of "abuse" in his Encyclopédie, he wrote," [A]s with languages there are many ways to speak against the rules of grammar. No longer do they see in a pediment the representation of a roof, but because of the fortuitous relation of the form of necessity with a geometrical figure, the roof is to their eyes only a mysterious triangle, emblem of the divinity." [182]

Following the theory of Blondel, Quatremère conceived of architecture basically as a language, as a visual expression of its function and utility. Like other neoclassicists, he thought of the language of art as a language of symbolic forms. However, he believed that the revolutionary architects' solution went too far towards the individualism which lacked consistent principles. Quatremère wanted a more coherent and pure restoration of classicism. In his Encyclopédie, Quatremère de Quincy thus suggested a more sophisticated theory of character which separated it into three levels of general, essential and relative (imitative) characters.

Against both the romantic individualism of Boullée and Ledoux and the utilitarianism of Durand and Rondelet, Quatremère de Quincy also attempted to restore a

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[181] Ibid., p. 59

[182] Quatremère de Quincy, Encyclopédie méthodique, vol. 1. Quoted in Anthony Vidler, op. cit., p. 104

pure and original meaning of type by inventing the notion of Ideal type.[183] When challenged by archeological reality, Quatremère argued that reality is necessarily inferior to the Idea and the language could be read only for the initiatives of the *Beau Idéal*.[184] By doing so, he also restored the authority of nature in architecture. In fact, Quatremère maintained that nature is the absolute reference in architecture, freely citing Laugier. Yet, with the notion of Ideal type, Quatremère could avoid the problem of Laugier's theory -- literal imitation of nature as a model.

After the Restoration in 1815, with the emergence of Quatremère de Quincy as the permanent secretary of the Academy, the dominance of the practical approach to architecture during the first Empire was finally suppressed. The reform plan of the Ecole des Beaux-Arts proposed by Rondelet and Laborde was rejected in 1819 in favor of the establishment of the École Royale des Beaux-Arts in 1823. Architectural education remained in the Beaux-Arts section under the Institute, thus promoting the development of architecture as a liberal profession. During the Restoration, architecture was held as a prime example of aesthetic object while its technical aspects were taken by engineers.

Quatremère de Quincy fashioned his neoclassicism as a continuation of the effort to restore the classical order since the mid-eighteenth century. However, as Vidler pointed out in his "Idea of Type", there was a fundamental difference in classicism before and after the utilitarian approaches of Durand and Dubut. After Durand and Dubut, a ground was laid for eclecticism and commercialism, a combination of forms from different styles. In fact, this was why Quatremère was led to invent an abstract notion of *Beau Ideal*, detached from the reality of production. Quatremère's classicism, however, was only an attempt to salvage art from a sense of loss. The neoclassicism of Quatremère and the gothicism of romantics were only a nostalgic effort to return to the past golden age, when faced with

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[183] See Quatremère de Quincy, Dictionnaire (1825)

[184] In Quatremère de Quincy's invention, there was certainly a modern character as Sylvia Lavin argued. See Sylvia Lavin, Quatremère de Quincy and the Invention of a Modern Language of Architecture, (Cambrige, Mass: MIT Press) 1992

commercialism and individualism. While Quatremère wished to return to the golden past of classicism, a romantic Victor Hugo was pessimistic about the future.

If one claims that architecture is still to be a prime example of high art, Quatremère de Quincy's critiques of the revolutionary architects was a quite legitimate one. Adapting engineering principles to architecture while claiming its artistic character at the same time was, as discussed earlier, an ambiguous and even contradictory operation. The neoclassical idealism of Quatremère and the Academy was, however, truly anachronistic in view of the scientific and technological developments and extensive archeological discoveries. During the 1820s, there was already a development of consumer eclecticism, as seen in the geometrical types of utilitarian buildings such as the panopticon. Percier, Fontaine and Lebas all contributed to this development of utilitarian buildings in the 1820 and 30s. In the late 1820s, students of the École des Beaux-Arts were already very critical of Quatremère's academic doctrines. Fontaine and Percier's eclecticism was more popular than Quatremère's classicism among the students of the École.[185] Soon after, reform movements accelerated within and outside the Academy. Young romantic *pensionnaires* of the Academy came up with a new concept architecture with emphasis on function, material, construction and local conditions. Others demanded the reform the architectural discipline and teaching to more technologically oriented ones. I will discuss these changes in the next chapter.

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[185] Hélène Lipstadt, op. cit.

Part II

Iron Construction and Technological Utopia, 1830-1852

Chapter Four: Iron Construction, Romanticism and Technological Utopia, 1820s-34

Development of Iron construction as Structural and Decorative Elements, 1820-1830

Despite Quatremère de Quincy's dominance in the Academy, iron continued to be used in architecture during the Restoration (1816-1830), especially in floor and roof framing. The iron beams used for floor and roof framing were composite wrought iron beams which consisted of two horizontal plate girders connected by an arched plate bar with vertical struts, conceived by Ango around 1785.(fig. 25) In most cases, the iron beams were employed with hollow pots as a fireproof construction.[186] (fig.36) The wrought iron floor and roof framing was used extensively, especially after a Paris building ordinance of the early 1820s required iron to be employed for the floor and roof framing of theaters.[187] Because it was thought to be fireproof, it was also used for many government buildings such as the Bourse, the Palais Royale, the Chamber of Deputies and the Ministry of Finance (figs. 37, 38, 39)

During the Restoration, engineers made extensive progress in iron construction such as bridges. The engineer of the Ponts et Chaussées Louis Marie Henri Navier (1785-1836) and his brother Seguin first introduced the concept of a suspension bridge with detailed calculations in Rapport et mémoire sur les ponts suspendus (1823). Two years later, Seguin realized the project of a suspension bridge at Tournon over the Rhône.(figs.

[186] On the use of hollow pots, see Charles Eck, Traité de Construction en Pôteries et en Fer (Paris, 1836-1841)

[187] During the 1820s, at least dozen theaters were constructed in the Paris environs with iron roof and floor framing. Frances Steiner, French Iron Architecture, p. 76

40, 41) Advances were also made by engineers in experimental studies on the properties of material and the scientific theories of the behavior of structural elements. The differences between cast and wrought iron, which had already been known since the eighteenth century, were determined with greater exactitude. In 1826, Navier compiled all the previous experimental data on the resistance of wrought iron to tensile stress in his Résumé de leçons données à l'École Royale des Ponts et Chaussées. After critically examining the previous data by Perronet, Soufflot and Rondelet, as well as that of English engineers, he also presented his own findings. However, the most important contribution of Navier were his mathematical theories of structural mechanics. In 1824, Navier developed the theory of the modulus of elasticity, which Young had first defined years before as the ratio of load per the unit of cross-sectional area to unit of elongation produced. Navier also defined the moment of inertia and calculated its figures of resistance for various sections. Thus he was able to suggest the I section as the most efficient one. Being so confident of the rationality of their mathematical rigor and of their scientific methods of calculation, engineers went so far as to argue an aesthetics based on total devotion to the results of calculation. As early as 1823, when suggesting the suspension bridge, Navier defended the aesthetics of rational structure based on calculations: "...toutes les parties de ces nouvelles constructions sont assujetties à des règles exemptes d'arbitraire, dictées par la géométrie et la mécanique; la forme même est déterminée par les lois naturelles de l'équilibre et les caprices de goût ne pourront jamais en altérer l'élégance."[188] On the question of the monumental aesthetics of iron construction, Navier wrote in 1827, defending his project for the Ponts des Invalides; "une construction en fer, si l'on y trouve la grandeur et la simplicité des formes, peut, aussi bien qu'un édifice en pierre, mériter le titre de monument."[189]

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188 Navier, Rapport et mémoire sur les ponts suspendus (1823) Quoted in Lemoine, L'Architecture du fer, p. 260

189 Navier, De l'entreprise du pont des invalides (Paris: Didot, 1827) p. 4. .Quoted in Antione Picon, "Les premiers pas de la construction en métal," in Architecture et métal en France, 19e-20e siècles, ed. Frédéric Seitz (Paris: Éditions de l'école Hautes études en Sciences Sociales, 1994) p. 60

Most of the French theoretical and empirical studies on materials concentrated on wrought iron. Due to the lack of coke furnaces in France, cast iron was more expensive than wrought iron. Thus, unlike England where cast iron was produced at a cheaper price and widely used in architecture, in France, wrought iron bars were more frequently used. However, during the 1820s, cast iron elements such as grills, balconies, columns, staircases were also introduced into markets and began to be used in commercial and private buildings.[190] Since cast iron had more strength than wood and stone, the cast iron elements were used where both solidity and lightness of structure were required. For example, since slim cast iron columns could support several stories at a time, they were used in shops and bazaars where less visual obstruction was essential for the exhibition of commodities.[191] In most cases, these cast iron columns, decorations, metal gates, fences, staircases and lamps were used together with wrought iron floor and roof framing during the late 1820s. (figs. 42, 43)

With the introduction of cast iron elements, iron became not only a structural material, but also a decorative element, since, unlike wrought iron beams, the cast iron elements were used as visible elements of architecture rather than as an concealed structure. The cast iron elements were molded with conventional neoclassical or eclectic decorations from the Italian Renaissance and even the Alhambra. It might seem ironical that the cast iron elements were shaped with such decorations used in stone architecture while engineers were increasingly confident of the calculation of structural elements and even defended the aesthetic position based on it. However, it should be noted that it was only after 1850 that a new rationalist aesthetic position which argued for the congruence between material and form, a correspondence between decoration and structure, began to appear, condemning the romantic reproduction in iron of the eclectic ornamentation of stone.[192] Architects and

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[190]The cast iron column was first appeared as a solid cast iron column, but soon void column was more frequently used. Sometimes, coupled and tripled columns were employed instead of singled columns.
[191] Hervas used cast iron columns which allowed to open two stories show window in the shop, *Grand Colbert*. See Hautecœur, Histoire de l'Architecture Classique en France, vol. 6. p.142.
[192] This rationalist aesthetics was advocated by Blouet, Reynaud, Daly, and later Viollet-le-Duc and Gothic rationalists during the Second Empire.

engineers of this moment accepted the neoclassical and eclectic decorations of the cast iron elements without any contradiction. For example, an engineer Emile Matin employed a traditional decorative motif, which evoked Egyptian columns, in an iron suspension bridge.(fig. 44) Architects and engineers rather thought of the eclectic ornamentation of cast iron elements as a merit rather than a problem. Cast iron's capability of easily shaping decoration was considered as a further advantage beyond its material strength because this plasticity made it possible to overcome what they believed to be the aesthetic weakness of iron. In 1832 François Thiollet, an architect, stressed these dual advantages of cast iron construction in his Serrurerie et fonte de fer (Paris, 1832). Speaking about the cast iron structures which were employed in the textile factories in England during the late eighteenth century, but were not used in France until the 1830s (fig. 45), Thiollet regretted "que ce mode de construction tout à la fois élégant, solide et surtout indestructible par le feu, ne soit pas plus un usage chez nous. . . C'est dans les ornements en fonte que se décèlent le goût et l'adresse de nos plus habiles ornemanistes, et que sont rendus les dessins des architectes modernes qui ont su mettre à profit leurs études en Grèce et en Italie."[193]

The development of iron construction was accelerated during the reign of Louis Philippe after the 1830 July Revolution. The decade of the 1830s was highly experimental as builders searched for more rational and cheaper ways of utilizing iron since the price of iron was still high for its structural uses. Many variations of Ango beam were attempted by engineers and contractors, and diverse designs of floor and roof frames, such as St. Andre Cross (the lantern of Travernier's Galerie de fer of 1829) and lattice (roof frames of several Government buildings, arcades, theaters and the Brouse), appeared during the 1830s.(figs. 46, 47) The projects for the iron lantern of the cathedral of Chartres by Leturc, Roussel, and Martin and Mignon in 1836 showed most clearly the diversity of their attempts. (figs.- 48, 49, 50)

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[193] François Thiollet, "Introduction," Serrurerie et fonte de fer (Paris, 1832) He reused the same paragraph in his later publication. (See Lemoine, ibid., p. 256)

Contractors and engineers also tried to use cast and wrought iron to their best advantage. The modernization of the iron industry during the thirties increased the production of iron and lowered its price, making the combination of wrought and cast iron economically feasible. In his 1829 edition of the L'art de bâtir, Rondelet had already advocated their union on theoretical grounds: "Cast iron for compression, and wrought iron for bending."[194] The first French engineer to break away from the subservience to wooden forms in using iron was Camille Polonceau, an engineer of the École Polytechnique. He invented in 1839 a type of iron roofing which he believed would fulfill the several conditions of "durability, economy and simplicity, with the smallest possible dimensions." It was a triangular truss system with wrought iron bars, called the Polonceau truss. Polonceau explained: "All the systems of construction are satisfactory if they are durable and economical, or in other words, if all the materials are utilized to offer maximum resistance with smallest dimensions possible and if they are assembled with greatest simplicity."[195] The Polonceau truss enabled architects and engineers to span a longer distances with great economy. (fig. 66)

The diffusion of cast iron as both structural and decorative elements was facilitated by catalogues during the 1830s. Also, books of *serrurerie* carefully engraved in the grand format in the tradition of neoclassical works were published, and contributed to the dissemination of iron construction.[196] They gave technical examples of the realized projects with great details that constructors could directly exploit. During the early 1830s, pre-fabricated iron architecture also began to develop. Many types of iron construction such as kiosks, cast iron urban furniture, and other utilitarian buildings were produced industrially and sold through catalogues.[197] These iron constructions of the 1820s and 30s

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[194] Quoted in Steiner, op. cit., p. 79

[195] Camille Polonceau, "Notice sur un nouveau system de charpente en bois et en fer," Revue générale de l'architecture vol. 1 (1840) cols. 27-32. Translated in Steiner, op. cit., p. 82

[196] They were Bury and Hoyau, Modèles de serrurerie, 1826; Thiollet, Serrurerie et fonte de fer (Paris, 1832) Charles Eck, Traité de l'application du fer, de la fonte et de la tôle (Paris,1841); Leconte, Choix de nouveau modèles de serrurerie (1838)

[197] Lemoine, op. cit., p. 258

were documented in Serrurerie et Fonte de Fer, (Paris, 1832) and Nouveau recueil de menuiserie et décorations Intérieures et Extérieures (Paris 1837), published by François Thiollet. Charles Eck also published several books with illustrations of numerous examples of iron construction, such as Traité de construction en poteries et fer (Paris: Blosse, 1836-41) and Traité de l'application du fer, de la fonte et de la tôle dans les constructions cviles, industrielles et militaires (Paris, 1841).

Iron Construction, Mass Culture and Romanticism

With the use of iron not only for concealed structures but also for visible elements, there emerged new building types of iron construction, such as arcades, green houses, market halls, panoramas, and cafés. By the end of the 1820s, many such arcades covered with glass and iron skylights were built in Paris.(e.g., Gallerie Vivienne, 1823 by F. J. Delannoy; Passage Choiseul, 1825-27 by M. Tavernier; Gallerie de Fer, 1829 by Travernier; Passage de Bour-l'Abbé, 1827-28 by A. L. Lusson; the Palais Royale, 1828 by Fontaine)[198] (figs. 38, 46, 47) The Madeleine market hall, built in 1828 by Veugny, had an entirely iron structure. (fig. 51) In the 1830s, the Jardin d'hiver (1833) by Rouhault (fig. 52) and the Panorama (1838) by Hittorff were built of exposed iron structure.

These buildings in which iron construction was employed in visible structural elements were utilitarian and commercial buildings. The use of iron in such buildings was closely related to the emergence of mass culture since the late eighteenth century. The new culture of the urban public sphere had emerged in the form of public gatherings in cafes, clubs and in the streets, and it continued to grow during the Restoration. However, it was after 1830 that the urban masses began to emerge in large cities such as Paris. After the establishment of the July Monarchy, Louis Philippe introduced a radical policy of industrialization. It was during this period that France was industrialized in the real sense of the word. This rapid industrialization brought with it a sudden growth of urban

[198] For the Arcades of the nineteenth century, see J. F. Geist, Arcades (Cambridge: MIT Press, 1985)

population, creating historically unprecedented urban masses and a working class which confronted new urban life uncoupled from tradition. As a result of these changes, there emerged new forms of industrial mass culture such as caricature, newspapers, cafés, panoramas, dioramas and other leisure industries.[199]

The new material of iron was the most suitable material for buildings for the urban masses. Firstly, it was able to span a longer distance with fewer structural members; thus it was possible to house a large group of people and commodities with a minimum of visual and spatial interference. Secondly, since iron was fire resistant, it was believed that its use could prevent a disaster that could happen in the case of fire. As I already mentioned, in 1823 a building ordinance required the use of iron floor and roof structures for theaters to guarantee fire resistance. Thirdly, iron construction was economic and efficient for buildings constructed for utilitarian and temporary purposes. With standardized parts that could be assembled on site, iron construction took less time to build. The construction of the Panorama in the Champs Elysées, built by Hittorff in 1838, for instance, took only eight months. It was also economical since it was possible to re-use the material when building were demolished. Fourth, by the 1830s, iron was available at an affordable price because of an increase of production and thus, it could be used for mass cultural buildings such as theaters, cafes, winter gardens, arcades, shops, and market halls. Lastly, in aesthetic terms, cast iron elements also satisfied the new popular taste under the July Monarchy. Industrially produced cast iron elements with classical and eclectic decorations were well received by the new urban masses who were not engrossed in the artistic taste of classical idealism. Still expensive for general architectural use, the cast iron decorative elements applied to houses also represented the social, economic status of the emerging affluent bourgeoisie. The relationship between iron and the popular taste during the July

[199] By 1830 already 123 newspapers existed and after the 1830 Revolution, the leftist caricature newspaper, La Siluette and La Caricature, were published by Phillipon, making easy quick communication with public mass possible. In Paris around 1830 there were street cafes, public theaters, mime journalism, etc. See Judith Wechsler, "Caricature, Newspapers, and Politics- Paris in the 1830s," Studies in Visual Communication, p.1 . The same article is in A Human Comedy: Physiognomy and Caricature in 19th Century Paris (New York: Thames and Hudson, 1982)

Monarchy was most clearly represented in the re-embellishment of the Champs- Elysées as a new urban pleasure area. Jacques Ignace Hittorff, the liberal classicist architect of the Champs Elysées, described the goal of the project in his Mémoires sur l'Embellissement des Champs-Elysées, published in 1836: "Créer en faveur de la population une vaste champs de repos et d'amusement."[200] Hittorff embellished the Champs Elysées, setting up lamp standards and fountains of iron and bronze, and various shelters of iron. He used "exposed, slender iron colonnettes to support the corner porches in the restaurants and cafés in the Champs Elysées that he designed in the 40s."[201] (fig. 53, 54) In the Champs Elysées, one could also see the influence of a new mode of popular taste: polychromy, the introduction of new decorative elements derived from the Florentine Renaissance, modification of the relation of scale between ornaments and supports, and cast iron urban furniture. By 1845, the Champs Elysées was the place in Paris for popular public pleasure par excellence; there were buildings such as *theatres, bals, hippodromes, jardins d'hiver, cirques, bazaars, dioramas,*and *panoramas* which were built of iron. Susan Buck-Morss, in her book on Walter Benjamin, a celebrated German theorist of modern culture, well summarized the characteristics of the iron construction in relation to mass culture :

> It was in the building for the new mass culture that the principle of iron and glass construction proliferated, as first under the banner of purely utilitarian buildings: iron halls were built as warehouses, workshops, and factories, covered marketplaces and railway stations. As practical, protective shelters for a mass public, iron halls well suited the need for unbroken space, because of the expenses such construction allowed. Benjamin noted that these buildings were connected with transitoriness in both the spatial sense and the temporal one.[202]

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200 Jacques Ignace Hittorff, Mémoires sur l'embellissement des Champs-Elysées.(1836) P. 6
201 Donald D. Schneider, The Works and Doctrines of Jacques Ignace Hittorff (1792-1867) (New York, 1971) p. 428
202 Susan Buck-Morss, The Dialectics of Seeing (Cambridge, Mass: MIT Press, 1989) p. 129-30

Many architects who were engaged in iron construction were architect-engineers who were educated both in the École Polytechnique and the École des Beaux-Arts. For example, Charles Rouhault de Fleury, who built the Passage du Saumon with his father Herbert in 1828 and the Jardin des Plantes in Paris in 1833, was a pupil of Durand at the École Polytechnique before studying at the École des Beaux-Arts. The engineer-architects were using the products of modern industry and the new methods of construction, attempting to incorporate them to their architecture. However, a few Beaux-Arts trained architects who did not study at the École Polytechnique were also using iron construction in their architecture since the late 1820s. As I mentioned in the previous chapter, Percier and Fontaine introduced iron trusses in their works at Versailles and in great quantities at the Palais Royal in 1828. Fontaine also built an iron arcade, the Galerie d'Orléans in 1828. Hittorff employed iron experimentally in the iron roof frame of the theater of Ambique-Comique in 1828 (fig.55), and continued to use iron construction innovatively throughout his career. In fact, as Charles Eck's Traité de construction showed in 1836, by the middle of the 1830s, most leading architects of the period were making their roof trusses and floor joists of iron.

Most Beaux-Arts architects who used iron construction were from the liberal classicist school of Percier and Fontaine.[203] They shared with the Academy an attempt to revive and invigorate architecture which had been uninspiring since the rationalization by Durand and Rondelet, and the control of building production by the Bâtiments Civils. However, unlike Quatremère de Quincy, they did not escape from reality into idealism. Instead they tried to renew classicism by reinterpreting the classics. In other words, they were concerned with bringing the forces of the past to bear on the present. Thus, they tried to use antiquity in a liberating way, and admitted the variations of taste throughout history, recommending the distribution and decoration to be adapted to need, climate and exposition

[203] Hittorff, after working with Bélanger on the Halle au Blé, became a disciple of Percier. Victor Lenoir, the author of the *Bazaar en fer* of the 1830s, was a student of Achille Leclèrc, who in turn was a disciple of Percier. Ricard de Montferrand who built the cathedral of St. Isaac in St.-Petersburg with an iron dome was also a disciple of Percier. See Hautecœur, op.cit., vol.6. p. 184

of the present.[204] They used non-classical decorations such as Italian Renaissance, colored panels and even Gothic motifs. It must have been this liberal attitude that led the liberal classicists to use the new material freely for practical purposes. Adapted well to the new liberal tendencies that introduced non-classical ornament and color and texture of materials, iron elements formed the facades of many private and commercial buildings.

Iron construction was also closely associated with the romantic tendency that emerged in the early nineteenth century.[205] In the early nineteenth century, the new anti-classical aesthetic tendency, generally called Romanticism, emerged in painting and literature, stressing the aesthetics of the picturesque and the sublime rather than the beauty of neoclassicism. As discussed earlier, the Romantic aesthetics were associated with iron constructions, such as iron bridges and the Halle au Blé, from the inception. The iron bridges of the early nineteenth century had not only been an object of romantic admiration but also the frequent subject of Romantic paintings. This association between the Romantic aesthetics and iron construction continued well into the 1830s. When Charles Rouhault de Fleury published Le Museum Royal d'Histoire Naturelle in 1837, he also wrote about the picturesque quality of his Jardin des Plants, built in 1836: "La vérité des formes des grands et des petit pavillons, et des longues serres courbes, en projetant l'une sur l'autre des masses transparentes couronnées par les beaux arbres verts du labyrinthe, produit des effets de perspective pittoresques auxquels le soleil ajoute un effet remarquable."[206]

Although there was no Romantic movement in architecture comparable to that of painting and literature, the new romantic tendency permeated architecture as well in the 1820s.[207] Liberal classicist as he was, Hittorff was certainly a leader of the new Romantic

[204] Hautecœur, op.cit., vol.6, p. 167
[205] The connection between iron and romantic tendency in architecture during the 1820s and 30s was succinctly mentioned by scholars, but without extensive discussion. This relationship has never been fully explained. See Steiner, French Iron Architecture and David Van Zanten, The Architectural Polychromy of the 1830s (New York, 1977)
[206] Quoted in Lemoine, op. cit., p.132
[207] As a matter of fact, the romantic sensibility that emphasized the artistic genius and the sublime aesthetic had existed since the late eighteenth century in neoclassical architecture of Ledoux, Boullée and Leques.

tendency in architecture. He was followed by the next generation of Romantic *pensionnaires* of the Prix de Rome at the end of the 1820s, such as Duban, Duc, Labrouste and Vaudoyer, as I will discuss later.

The relationship between Romanticism and iron construction, however, should be understood less in terms of the aesthetic effects of industrial objects, such as the picturesque and sublime, concepts which were basically related to pictorial representation, than in terms of their anti-academic, anti-Classical principles.[208] First of all, Romanticism emphasized the individual sensibility of artists rather than the universal reason of neoclassicism as the reference for the aesthetic judgment. Thus, it was surface, texture and decoration rather than rational principles that were important to the aesthetic experience of Romanticism. The interest in the new material of iron was a part of the Romantic admiration for color and texture of material, which was also manifest in the works of Romantic painters of the 1830s such as Delacroix. For example, when Hittorff became the architect for the *Place de la Concorde* in place of A.- L. Lusson and Destouches in 1833, he designed fountains made of iron as were all the lamps and standards set around the square, employing natural polychromy of iron. In his Traité de l'application du fer, de la fonte et de la tôle, printed in 1841, Charles Eck extolled Hittorff for his originality in using iron in this way.[209] (fig. 56)

Secondly, against Classical idealism, Romanticism meant to give significance to that which is common, ordinary and banal in everyday life.[210] Thus, Romantic architects tried to rediscover the past with renewed interest in the real life in the building. The discovery of ancient architectural polychromy in the 1820s was the product of the romantic reinterpretation of antique architecture.[211] As romantic artists used past styles to express

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[208] For the definition of Romanticism, see Hugh Honour, Romanticism (New York: Harper & Row, 1979) especially Chapter one.
[209] Charles Eck, Traité de l'application du fer, de la fonte et de la tôle (1841) p. 27, 28.
[210] See Hugh Honour, op.cit. It is well known that a Romantic painter Delacroix used the techniques of lithography in his paintings.
[211] Polychromy, which was at first conjectured for a long time, was discovered as scientific archeology developed at the end of the eighteenth century. In 1815, Quatremère de Quincy first discovered polychromy in ancient Greek sculpture. However, Quatremère was a platonic idealist and comprehended the polychromy

individual emotions of the present, romantic architects used past principles for the present. Hittorff used various past styles, discovered the polychromy of the ancient Greek architecture, and applied it freely to modern architecture.[212] What Hittorff's polychromy campaign (von Klenze and Semper as well) brought about was not only the revival of painted polychromy but also the use of colored materials such as *lave emailée* (enamelled lava), colored bricks, which provided a solution to the fragility of painted colors. Romantic architects did not refuse to use industrial materials and construction technology either. The use of cast iron elements in architecture partially resulted from the interest in polychromy of material. When polychromy fully developed as a theory of color, it was applied to cover the aesthetic weakness of iron. For example, in 1851 Owen Jones applied a system of polychromy which he elaborated based on his theory of color to the iron structure of the Crystal Palace. In fact, the principle of polychromy marked the end of the neoclassical principle of simplicity of masses in the contrast of light and shadow. Thus, in his proposal for an iron hospital in 1847, the architect-engineer A. Romand suggested the use of polychromy as a solution to the problem of iron's weakness in terms of classical aesthetics.(fig. 57) He wrote:

> Les constructions en tôle ont un défaut capital qui mérite d'être signalé. Elles manquent de relief, de cette opposition d'ombre et de lumière nécessaire pour en faire ressortir le dessin. Vues de loin, elles sont massives et privées de ces fortes saillies que dessinent les lignes harmonieuses des anciens monuments; mais comme, pour leur conservation, on est obligé de les peindre, et qu'un choix heureux, une disposition convenable des

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in terms of the classical doctrine. Gau discovered polychromy in 1822. Hittorff first discovered polychromy in the Sicilian temple in 1823 with Van Zanth. He presented a polychromy paper to the Academy, where he said that"ancients were in the habit of using color and painted ornament to enhance not only their interior of the temple but also external walls of...." In 1831 he published a book, which arouse a debate with Raoul Rochette, protégé of Quatremère de Quincy. However, as a classical architect, Hittorff also tried to preserve the received classical vision of Greek architecture in interpreting the polychromy. In fact, contemporary critics drew an analogy between the polychromy and romanticism. For a fuller account of polychromy see David Van Zanten, The Architectural Polychromy of the 1830s (New York, 1977) and also "Architectural polychromy: life in architecture," in The Beaux-Arts and Nineteenth-Century French Architecture (Cambridge: MIT Press, 1982)

[212] What Hittorff wanted by applying polychromy was to revive the ancient culture of classicism.

couleurs appliquées n'augmente pas le chiffre du devis, il suit que, vues de près, la légèreté, la netteté et le fini de l'ornementation, quelques dorures sagement et modérément placées, leur donnent un aspect riche, coquet et élégant, qui satisfait et étonne les yeux.[213]

Romantic Revolt against the Academy

By introducing not only a new material and construction technology but also new aesthetic standards, the iron construction brought about a great impact on the Academy and the Ecole des Beaux-Arts as well. The Academy and the Beaux-Arts at that time were under the firm control of Quatremère de Quincy, *doctrinnaire* of Classical idealism. After the Restoration in 1815, the class of Beaux-Arts of the Institute regained its old name of the Academie des Beaux-Arts and in 1816, Quatremère de Quincy was appointed *Secretaire perpétuel* of the Academy. Quatremère imposed more strict Classical doctrines on the Academy and the École des Beaux-Arts, re-established in 1819 under the control of the new Academy. In the late eighteenth century, Neoclassicism had betrayed Romantic tendencies which rejected the Orders and proportions as the basis of architecture and emphasized instead the experience of building's masses and volumes in light and shade.[214] Since his early career, Quatremère de Quincy had opposed the Romantic tendency of architectural composition in the Academy and the École, and tried to restore Classical idealism.[215] For him, the most important aspect of architecture was the imitation of nature, which was manifested in the Orders of Greek temples, as was explained by Laugier in the mid-eighteenth century. However, by his time, archeological discoveries proved that there were various types of non-Classical architecture such as Byzantine and Indian architecture and that the primitive

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213 A. Romand, "Sur un Hôpital en Fer: Construit au Camp Jacob," RGA vol. 7 (1847-8) col.144

214 As representative examples, see Boullée and Ledoux' architecture. But, Leroy, Professor of the Ecole d'architecture under the Academy, was the one who initiated this Romantic interpretation of classical architecture. For the Romantic tendencies, see Richard Chafee, "The Teaching of Archiecture at the Ecole des Beaux-arts, in The Architecture of the Ecole des Beaux-Arts, and also Szambien's J.-N.-L.Durand.

215 See his attempt in Egyptian. . .(1785), where he argued that Greek temple was the only type of Ideal beauty. In his Méthodique. . .(1788) Quatremère criticized Ledoux's architecture as abuse of Classical principles

hut of Greek temples was simply one of them. But, Quatremère maintained that architecture is more than a constructional type; it is a spiritual art. Attempting to restore Classicism based on the Greek model, Quatremère then invented the notion of Ideal beauty, an ideal imitation of nature as opposed to a literary imitation; only Greek temples among other types of architecture had accomplished this.

However, despite Quatremère de Quincy's theoretical efforts, doctrines of Classical idealism which maintained architecture as a higher form of art were fragile and already seriously threatened by the emergence of technological mass culture. First of all, modern technological inventions such as photography and iron construction, although temporarily spared from the realm of art, ultimately challenged the very classical concept of art itself.[216] For example, the invention of photography in 1844, which was prefigured by the diorama of the 1820s, challenged the traditional concept of art, attempting a perfect imitation of nature by means of technical artifice. Likewise, as discussed earlier, light structures of iron construction based on calculations challenged the traditional aesthetic norms of Classical architecture based on stone masonry construction. In 1831 Léonce Reynaud, a former student of the École Polytechnique, accurately pointed out the limitation of the Academy's classical norms in dealing with iron constructions:

> . . . l'étude des constructions antiques, suffisante dans quelques cas particuliers, ne l'est plus lorsque'il faut employer les matériaux que fournit une industrie plus avancée; que *les constructions en fer*, par exemple, qui paraissent devoir prendre un développement auquel il est difficile d'assigner une limite, exigent des connaissances scientifiques que l'expérience seule peut donner.[217]

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216 The analogy between photography and iron construction as an opposition to the traditional concept of art continued even during the second half of the nineteenth century. See, for instance, Charles Garnier, A Travers les Arts, causeries et mélanges (Paris: Hachette, 1869)

217 Léonce Reynaud, "Mémoire sur l'organisation à Donner au Corps des Architectes,"Journal des bâtiments des arts et métiers (1831-32) p.194f. This was reprinted in Journal du génie civil (1831), p. 292

Furthermore, traditional academic art had already lost its communicative ability as a language as a result of the emergence of urban masses whose mode of reception of art was changed by the new technological means of communication in mass culture, such as caricature and mass journalism. Léonce Reynaud eloquently pointed out once again the limitation of the academic concept of art in the modern mass society in 1831 while criticizing the Academy's reform plan of the École after the July Revolution. He wrote, ". . . ils[artists] ne pouvaient occuper qu'une place très secondaire dans la hiérarchie sociale à une *époque où des caricatures et des chansons jouissent seules du privilège de captiver les masses.*[218] This loss of arts' traditional communicative role in modern society was also what a romantic writer Victor Hugo mourned when he wrote in 1832 in his Notre Dame de Paris, "ceci tuera cela" : the dilemma of architectural expression caused by a new literary form of communication with the public.

Since iron construction was connected with industrialism, commercialism and mass culture, Quatremère de Quincy and the Academy depreciated the utilitarian and commercial buildings of iron construction. With his elitist and idealist concept of art and culture, Quatremère criticized the reproduction of Neoclassical ornament in industrial products as a vulgarization of taste which exclusively belongs to elite artists. Since his ideal concept of architecture favored the homogeneous construction of stone, he even opposed the use of iron as a major construction material. Thus, when iron construction emerged as a distinctive genre of construction in the 1820s, Quatremère de Quincy separated architecture of high art from mere utilitarian buildings, and considered the iron construction as secondary architecture. To the problem of communication of classical art, he responded by distinguishing ideal beauty from relative beauty, which considered architecture as a mode of expression, or representation. He regarded the relative beauty, which depended on the direct sensation of mass in light and shadow, as the secondary realm of architectural effect;

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[218] Ibid., p. 291

whereas ideal beauty of architecture could be expressed only through the Orders and proportions.[219]

Quatremère's theoretical attempts to preserve the realm of art from the encroachment of industry and mass culture, however, were not quite effective.[220] Already in the 1820s, many students of the École des Beaux-Arts sided with the liberal and eclectic classicism of Percier, Fontaine and Hittorff rather than Quatremère's Classical idealism, and followed new liberal and romantic tendencies which emerged from the late 20s and continued throughout the 30s. For instance, in 1826 when "...Quatremère depreciated in his eulogy of the deceased architect M.- J. Hurtault, the varied, incidental architecture of Paris streets, praising only the statuesque severity of Greco- Roman colonnades, students hooted him down so that troops had to be called in to restore order."[221] Similar incidents of disruption by École students occurred several times in the 1820s.[222]

However, the first and most serious challenge against the Classical doctrines of Quatremère de Quincy and the Academy came up in the works of the young *pensionnaires* of the late 1820s: Félix Duban, Henri Labrouste, Louis Duc, and Léon Vaudoyer. Unlike liberal Classicists of the previous generation, these young architects directly challenged the Classical idealism of the Academy. They were the winners of the Grand Prix between 1823 and 1827 and travelled to Rome to study antique architecture in successive years. They became acquainted with each other during their stay in the French Academy in Rome,

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219 See Van Zanten, "Architectural Composition at the Ecole des Beaux-Arts from Charles Percier to Charles Garnier," in The Architecture of the Ecole des Beaux-Arts, p.191

220 The recent revisionist study of Quatremère de Quincy by Sylvia Lavin revealed that Quatremère in fact was the first theoritician who developed the modern notion of architecture as language based on connventional model. This new understanding of theoretical endeavour of Quatremère is consistent with my argument that his attempt was to save architecture's commucative role in modern society. See Sylvia Lavin, Quatremère de Quincy and the Invention of a Modern Language (Cambridge: MIT Press, 1992)

221 David Van Zanten, "Architectural Polychromy: life in Architecture" in The Beaux Arts and the Architecture. ed, by Robin Middleton (Cambridge: MIT Press, 1982) p.197.

222 see Van Zanten, "Architectural Composition at the Ecole des Beaux-Arts from Charles Percier to Charles Garnier," in The Architecture of the Ecole des Beaux-Arts

where they emerged as a group of rebels against the doctrines of Quatremère de Quincy, travelling and developing a new concept of architecture together.[223]

Although there were differences in their thinking, what this loosely connected group of *pensionnaires* had in common was the idea that architecture is not a representation of Ideal beauty, but rather a structural embodiment of social, cultural and technological reality. Instead of idealizing the Greek temple as an eternal past, a representation of ideal beauty in Orders and proportions, the young architects of the romantic generation saw architecture as a physical, structural organization determined by program, material, method of construction and climate and thus, as historical processes with no eternal formal reference. They were interested in the relationship of architecture to the communities and localities of which it was to be a part, and studied various past architectural styles from a functional and structural point of view. Through the realistic and scientific study of the past styles, they attempted to find new principles of architecture, which they could use in order to create new modern architecture.

The so-called Romantic *pensionnaires* 'anti-academic concept of architecture was most clearly demonstrated in 1829, in Duban's fifth envoi, Protestant church, and Labrouste's fourth *envoi* to the Academy, reconstruction of the temples at Paestum. Labrouste's reconstruction of the Greek temples at Paestum especially infuriated Quatremère and the Academy by restoring the temples as practical and rational stone structures based on purely functional and structural necessity. In his essay on Labrouste, Neil Levine showed that it was the Précis d'histoire that Labrouste accompanied with his *envoi* that contained his anti-academic and functional idea of architecture.[224] In this pamphlet, Labrouste interpreted each temple as a reflection of different stages in the process of adapting themselves to the local conditions of the Greek colony, rather than as a representation of beauty through the Orders. Thus he came to the conclusion that the

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223 For a detailed discussion of the Romantic pensionnaires' activities in Rome, see Van Zanten, Chapter One, "The Student Works: The *Envois* from the French Academy in Rome," Designing Paris,1987

224Neil Levine, "Romantic Idea of Architectural Legibility: Hneri Labrouste and the Neo-Grec in the Ecole des Beaux-Arts," in The Architecture of the Ecole des Beaux-Arts chronological order of the construction of the three temples at Paestum was the reverse of what the Academy had believed based on the progress of the orders of temples.[225] Labrouste even reconstructed one of the temples as a portico, a stoa of public meetings and restored decorative paintings and writings on the wall as expressions of the meaning of the building. While Quatremère's classicism believed in a correspondence between structural form and meaning which was manifested in Orders, the Romantics were interested in building as structure. For the communication of the meaning of architecture, Labrouste used purely abstract and mass cultural means, such as words.

It is not clear what motivated the Romantic *pensionnaires*' thinking at that historical moment. Historians have usually pointed out two main circumstantial factors which influenced these Romantic architects:[226] First, in their works, there was an aspect of continuity of the rationalist trends within the Academy that had existed since the late eighteenth century. For example, the interest in non-classical architecture like the Estruscan and the Byzantine that had characterized the Romantic tendency, were in fact the outcome of the archeological study of antiquity which had started in the late eighteenth century.[227] Huyot (1780-1840), Professor de l'Histoire de l'Architecture at the École and the mentor of the Romantic *pensionnaires*, explored Egyptian architecture and encouraged his students to reach outside Roman antiquity. The Romantic *pensionnaires*' use of color in their drawings was also influenced by the discovery of architectural polychromy in Sicilian temples in 1823 by Hittorff and Van Zanth, which challenged Winklemann and Quatremère's notion of ideal white classical architecture. After Hittorff's discovery, Labrouste himself travelled to the Sicilian temples in 1826 to confirm it. But, while

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[225] Ibid.
[226] See Robin Middleton, "The Rationalist Interpretations of Classicism of Léonce Reynaud and Viollet-le-Duc," AA files II (1986) and Barry Bergdoll, Léon Vaudoyer: Historicism in the Age of Industry (Cambridge: MIT Press, 1994) Whereas, Van Zanten and Levine did not really explain causes of this change.
[227] Historical approach to Classicism, as opposed to Laugier's idealized model, began with the archeological discovery in the mid-eighteenth century. Soufflot discovered Paestum, and Julien David Leroy published Les ruines des plus beaux monuments de la Grèce... in 1758. They already assumed history as progress.

Hittorff, like other contemporary classical architects such as Semper, interpreted architectural polychromy as a means of perfecting the ideal beauty of Classical architecture, the Romantic *pensionnaires* considered it a sign of life and later used it in their reconstruction of antique buildings.

Secondly, the Romantic *pensionnaires'* historicist thinking was greatly influenced by Romantic historians of the 1820s, such as François Guizot (1787-1874), Augustine Thierry (1795-1856) and Michelet (1798-1874), who were in turn influenced by the Saint-Simonian concept of history.[228] As Robin Middleton analyzed, the liberal historians were preaching their theory of history since the early 20s, arguing history as a continual progress or a struggle between opposing principles.[229] Their teaching influenced the young Romantics and enabled them to put the historical instruction of the École des Beaux Arts in a new perspective. The liberal historians lesson was, as Barry Bergdoll writes, "that history could be subject to a rational analysis that would reveal its underlying laws and that these laws made it possible not only to comprehend the meaning of the myriad of events, lives and facts about the past but also the sense of the present in a larger chain of the event."[230]

However, these factors did not explain what motivated the Romantic *pensionnaires'* particular approach to architecture. The Romantic *pensionnaires'* functional and structural attitudes toward architecture against Classical idealism, especially that of Labrouste, I would argue, came directly from the encounter with new utilitarian and functional buildings and with new construction technology which emerged beginning in the 1820s. As already discussed, the iron construction rejected the Neoclassical notion of the rationality of structure based on mass and geometry, and emphasized instead reality of structure. The

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228 Guizot was in close contact with Saint-Simonists. Thierry was a secretary of Saint-Simon in the 1810s (1814-1817).

229 See Robin Middleton, "The Rationalist Interpretations of Classicism of Léonce Reynaud and Viollet-le-Duc" AA files II (1986) and Van Zanten, Designing Paris (Cambridge: The MIT Press, 1980) However, only Blouet and Gilbert attended Guizot's lecture.

230 Barry Bergdoll, Leon Vaudoyer: Historicism in the Age of Industry (Cambridge: MIT Press, 1994) p. 42.

ideal, rather than real, homogeneity of Neoclassical architecture was thus challenged by the real heterogeneity of materials and structures. Although the pensionnaires studied at the Ecole, they were also strongly influenced by Romanticism while they were in Paris.[231] The new industrial and utilitarian buildings, associated with Romantic aesthetic principles, must have influenced the pensionnaires, suggesting for them especially new concepts of structure and function in architecture. Through a careful and rational study of real, not idealized, antique monuments with their fresh eyes during their stay in the French Academy in Rome, the *pensionnaires* of the Romantic period were thus able to develop the functional and structural concept of architecture which emphasized programs, materials and methods of construction. In 1830 in his letter to his brother Théodore, Henri Labrouste, a leader of the 1830s' Romantic rationalists, spelled out his functional structural concept of architecture:

> J'ai rédigé quelques programmes pour exercer utilement les débutants, je veux leur apprendre à composer avec des moyens très simples.
>
> . . . la solidité dépend plus de la combination des matériaux que de leur masse et des qu'ils connaissent les prémirs principes de construction, je leur dis qu'ils doivent tirer de la construction elle-même une ornamentation raisonnée, expressive.
>
> Je leur répète souvent que les arts ont le pouvoir d'embellir toute chose; mais j'insiste pour qu'ils comprennent que la forme, en architecture, doit toujours être appropriée à la fonction qu'on lui destine.[232]

As for the importance of construction, a few teachers of the École in the early 1820s, apparently influenced by the development of the new construction technology and the teaching of the new engineering schools, had already stressed construction, in addition

[231] Vaudoyer carried with him Charles Percier's folio Choix des plus célèbres maisons de plaisance de Rome (1809), and his letter to his father revealed his romantic inclination. See Van Zanten, op cit., pp. 6-18

[232] Henri Labrouste, "Letter to Théodore," (20 Nov. 1830) Souvenirs d'Henri Labrouste, notes recueillies et classées par ses enfants, (1928) p. 24

to the Orders and composition, as the basis of architecture.[233] For instance, Jean Marie Guénepin, a former student of the École Polytechnique and winner of the Grand Prix of 1805, repeatedly told his students that in architecture "everything[forms] ought to be motivated by conventions and by construction."[234] Thus, in 1823 when the curriculum of the new École des Beaux-Arts was finally set up by government regulation, construction courses became a requirement. The construction courses were considered to be as important as composition in the École.[235]

However, what Labrouste was critical of was that the teaching of construction at the École was separated from that of composition as if they were different matters. He recalled this in the review of the student works of the École des Beaux-Arts in 1839:

> Mais l'experience a bientôt montré que le dessin n'était pas le seul exercice à proposer aux élèves, . . nous avons vu bientôt ces jeunes gens présenter jusqu'à dix feuilles couvertes de nombreux détails de mécanique ou de serrurerie, ou des développements compliqués d'une épure de stéréotomie. . . .
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> . . . . Les projets de construction sont toujours assez nombreux, et l'on devrait en féliciter les auteurs: cependant, on remarque peu d'imagination dans ces projets, ils paraissent copiés les uns sur les autres: les élèves ne semblent prendre part à ces concours qu'avec une certaine répugnance, et, pour ainsi dire, pour s'en débarasser, par la seule raison qu'ils sont obligatoires. Cela vient peut-être de ce que le plan de l'édifice dont ils doivent étudier la construction leur est imposé par le programme: l'etude de la construction devient alors pour eux une étude des détails du métier, qu'ils copient dans les manuels de serrurerie ou de charpenterie, et

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233 Of course, attempts had been made in the École to teach construction to architectural students after the reform of the Ecole. In 1806, Rondelet became Professor of construction at the Ecole des Beaux-Arts and taught courses of stereotomy. He almost succeeded in transforming the Ecole des Beaux-Arts to a more practical school in 1815. But Rondelet's proposal had been finally rejected by Quatremère de Quincy after the Restoration.

234 Quoted in Donald Drew Egbert, The Beaux-Arts Tradition in French Architecture, p. 50. See also Hautecœur, op. cit., no. 6, p. 239. Originally in RGA (1842) cols. 74-79.

235 Out of four *concoures* of construction, one was on iron. See Richard Chafee, "The Teaching of the Architecture at the Ecole des Beaux-Arts," in The Architecture of the Ecole des Beaux-Arts (New York: MOMA, 1977) p. 83.

n'a plus l'intérêt qu'elle présente quand elle consiste dans la combinaison de toutes les parties architecturales qui doivent concourir non-seulement à la convenance et à la beauté d'un édifice, mais encore à sa solidité, et à la prévision des moyens de l'exécuter. Si les élèves avaient à composer toutes les parties de l'édifice dont ils présentent la construction détaillée, ils pourraient alors exercer leur jugement comme leur imagination, et ces études auraient pour eux plus d'intérêt, et, je crois, plus de profit. Quant à moi, je regrette que les concours de construction soient indépendants de cours d'architecture: c'est presque admettre que l'architecture et la construction sont deux choses différentes qui peuvent s'étudier séparément...[236]

Labrouste believed that construction should be integrated into architectural composition. This functional and structural concept of architecture enabled the Romantics to use the modern material that Neoclassical idealism had refused to use. Hittorff and Labrouste, in particular, among other Romantic *pensionnaires*, were interested in applying the modern material and methods of construction to architecture and used iron in their buildings with remarkable structural innovations.[237] In 1838 Hittorff designed the Panorama in the Champs Elysées, applying a suspension roof system. Labrouste used iron structure for the Bibliothèque Ste.-Geneviève in combination with stone. The Bibliothèque Ste.-Geneviève designed in 1839, in particular, proved Labrouste's extraordinary talent to integrate the iron construction with his anti-academic liberal aesthetics in order to create a new modern architecture. As for these two buildings, I will discuss more in the next chapter.

The Romantic *pensionnaires* all returned from Rome to Paris around 1830. At the request of École students, the *pensionnaires* opened their ateliers in the early thirties and became the leaders of Romantic students in the 30s. It was after their return to Paris that the Romantic movement of liberal architects in the 20s actually began to have visible

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[236] Henri Labrouste, "Melanges, nouvelles, travaux des élèves de l'école d'architecture de Paris pendant l'année 1839," RGA vol.1 (1840) col. 59.

[237] Other Romantics used iron only as a roof structure. For example, see Duc's Palais de Justice (1857-68)

shape.[238] Shortly after the July Revolution in 1830, when students of the École des Beaux-Arts demonstrated against the Academy and the École, asking for more freedom of imagination, Labrouste and Duban supported the students' action. In 1831, a *Commission des Beaux-arts* to inquire into the teaching at the École des Beaux-Arts was organized by Comte de Montalembert, a new *Ministre de l'Instruction Publique*. And the leaders of the romantic *pensionnaires*, Duban and Labrouste, along with a Romantic painter Delacroix, were made members of the committee. However, at the protest of the members of the Academy, the reform plan was suppressed. With the arrival of the Romantic *pensionnaires*, however, emphasis in the education of architecture at the Ecole shifted from the composition of enclosed space to the structural organism enclosing it, "from the gracious *marche* to the assemblage of clearly separated parts."[239] It was no wonder that the students of Labrouste's atelier never succeeded in winning the Grand Prix. As Viollet-le-Duc later described, Labrouste's atelier was "un centre d'étude d'architecture absolument étranger à l'enseignement académique, pour ne pas dire opposé."[240]

Technological Utopia: Architecture as a Positive Science

Although the Romantic tendency was instrumental in spreading the use of iron in architecture as a structural and decorative element during the 1820s and 30s, Romantics did not see iron as a positive factor to restore the unity to the fragmented culture caused by modern science and industry, and capitalism. In this respect, Romanticism was a contradictory movement: it was basically anti-Enlightenment and anti-rationalism, and like Quatremère de Quincy's Classical idealism, it was a protest against the bourgeois capitalist world. However, in protesting bourgeois culture, Romantics nurtured with liberal taste the

[238]Although the pensionnaires were the leaders of the Romantics, there was also a distance between them. In the thirties, there was a Bohemian current among the Ecole students. They criticized the Ecole and asked for the freedom of imagination. In 1833, a Romantic critic Borel criticized Duban and Labrouste as neoclassic. Pommier and Chenevard were praised as the only thinking architects by Borel

[239]See Van Zanten, "Architectural Composition at the Ecole des Beaux-Arts from Charles Percier to Charles Garnier," in The Architecture of the Ecole des Beaux-Arts (1977)

[240]. Quoted in Lipstadt, op. cit., p. 52

commercial and industrial buildings of decorative iron elements, against which the Romantics protested. In other words, while Romantics shared the concern about the fragmentation of culture with the Academy, their solutions were quite contrary to the Academy, paradoxically encouraging the use of decorative iron elements. A Marxist critic, Ernest Fisher, well summarized this contradiction of romantic writers: ". . . in their romantic protest against bourgeois values and in their emancipation which ultimately forced them into the role of Bohemians, such [Romantic] writers made of their works precisely what they wanted to denounce; a market commodity."[241] This was the reason why Romantics such as Victor Hugo called for the return to the Middle Age. The Romantic medievalists saw in the dominance of new forms of technological mass culture the ultimate destruction of the traditional values of art and architecture. It was in this context that Hugo wrote, "ceci tuera cela," meaning the printed words killed architecture in his famous novel, Notre Dame de Paris, published in 1832.

While Hugo saw in the emergence of mass journalism the death of architecture, utopian socialists, while being equally critical of bourgeois capitalism, saw in the same modern technological mass culture a vision and remedy for the future.[242] Thus, in 1834, Victor Considérant, a disciple of Fourier, criticized Hugo's pessimism, saying that Hugo's conclusion that the printed word had killed architecture showed only Hugo's immense self-satisfaction with his own art. He wrote: "M. Hugo the poet, who because he creates poetry with a pen, has taken it into his head that mankind could no longer create poetry except with pens. . . The architecture they will tell you is dead and buried has still a long way to grow to attain its height."[243]

From the early nineteenth century, utopian socialists such as Comte de Saint-Simon and Charles Fourier tried to solve the social disorder and the industrial anarchy that the

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[241] Ernest Fischer, The Necessity of Art (New York: Penguin Books, 1963) p. 56
[242] In fact, many Romantics converted to utopians in the 1830s
[243] Victor Considérant, Considérations sociales sur l'architectonique (1834-8) Quoted in Donald Drew Egbert, Social Radicalism and the Arts.

French Revolution and the capitalist economy created. The utopians envisioned a new harmonious social order in which science and industry would guarantee the progress of society and benefits for the people. While they were critical of the capitalist system mainly because of its anarchic state of production and inhumane competition, they also believed that the development of modern science and industrialization were positive factors for social progress provided that they were properly reorganized. In the new order of industrial society, the utopians believed that scientific and technical progress would bring about social betterment and ultimately the elimination of class divisions.

Saint-Simon, in particular, accepted wholeheartedly the virtue of science and industry as liberating forces and believed that all the problems of society could be avoided by the reorganization of society and the sciences. Saint-Simon's new society was organized based on positivistic knowledge, and the role of scientists, industrialists and artists were accordingly assigned. Later, Saint-Simon asserted a need for a new religion founded on love and fraternity, preaching *Nouveau Christianisme*. Fourier, on the other hand, had a vision of a fecund and harmonious agrarian golden age. He argued that the social anarchy after the French Revolution could be ended by finding a new social order. His principle of harmony opposed the industrial civilization and envisioned a free association of people in the communities called Phalansteries.[244]

Furthermore, the utopians had a concept of art and architecture which was quite the opposite of the Romantics. For them, art was a kind of positive science which had a specific social, utilitarian and moral function. Architecture, with its inherent utilitarian purpose, fit this description all the more. Thus, unlike Romantics who tried to preserve the value of art by protecting it from the encroachment of modern industry and utilitarianism, the utopians focused on the positive aspects of modern technological inventions and regarded them as social utilities. The Saint-Simonian concept of art as a social utility

244 In fact, many Romantics converted to utopians in the thirties. Fourier's utopia especially attracted many artists because it allowed a high degree of individualism.

enabled architects and engineers to attempt to change architecture to a positive discipline based on positive knowledge of sciences and industry

Already beginning in the early 1820s, a group of architects and critics, influenced by the Saint-Simonian concept of art and science, demanded a radical reform of the architectural profession and the educational system of the École des Beaux-Arts. Their ideas of reform were fundamentally different from the Romantic *pensionnaires*' in that they demanded a radical renewal of the concept of architecture from the art of drawing and composition to one that was based on positive scientific knowledge.

These critics were led by Maurice Jeannin, a scientist and government *functionnaire,* and Léonce Reynaud, a young Saint-Simonist architect-engineer who had studied both at the École des Beaux-Arts and at the École Polytechnique. In the early 1820s, Maurice Jeannin had already advocated a rationalist concept of architecture which was based on scientific calculation and construction.[245] In 1829, in an article published in Journal du génie civil, Jeannin argued that the architectural discipline should be based on positive sciences such as descriptive geometry, statics, mechanics and physics. Without such knowledge, he argued, architects could not understand the resistance of materials and thus, the equilibrium and solidity of construction. Criticizing academic architects' lack of such knowledge, Jeannin argued that reform of the Academy and the École des Beaux-Arts was in order.[246] His model was obviously architects of the École Polytechnique.

In 1831, in his article, "Sur l'organisation à donner au corps des architectes," Léonce Reynaud maintained the same line of argument that the architectural profession should be organized on the basis of positive knowledge of modern sciences. In this article, Reynaud wrote critically of the academic architects' purely artistic approach to architecture:

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[245]Maurice Jeannin, Annales des bâtiments and annales Françaises des arts, VIII (1821), pp. 182-184. Hélène Lipstadt mentioned this in her introduction to Jeannin's 1829 article, "De la nécessité de réformer l'Académie et les écoles d'architecture pour les reconstituer sur de nouvelles bases," reprinted in the Les cahiers de le recherche architecturale, no. 2 (mars 1978).

[246] Maurice Jeannin, "De la nécessité de réformer l'Académie et les écoles d'architecture pour les reconstituer sur de nouvelles bases," Journal du génie civil (1829), reprinted in the Les cahiers de le recherche architecturale, no. 2 (mars, 1978)

"Les architectes modernes se regardant uniquement comme des artistes, se mettent soigneusement en dehors de toutes connaissances positives."[247] Reynaud even criticized the same limited view of architecture he believed was held by the commission, organized in 1831 to reform the teaching at the École des Beaux-Arts, of which the Romantic *pensionnaires*, such as Labrouste and Duban were members:

> . . . les architectes l'ont témoigné en adressant un mémoire au Ministre de l'Intérieur, peu de temps après la chute de l'ancien gouvernement qui avait étouffé leurs plaintes. Ils ont compris qu'à côté des critiques, ils devaient présenter des moyens d'organisation nouvelle; mais dans l'une et l'autre parties se trouvent des lacunes et des erreurs faciles à concevoir et auxquelles on devait s'attendre. Elle proviennent, et nous l'avons déjà indiqué, de cette opinion erronée qui les engage à se considérer uniquement comme des artistes, et qui les a empêchés de reconnaître, qu'en cette qualité, ils ne pouvaient occuper qu'une place très secondaire dans la hiérarchie sociale à une époque où des caricatures et des chansons jouissent seules du privilège de captiver les masses. Ils n'ont pas senti que l'oubli des sciences était la cause des maux dont ils se plaignaient, qu'elles seules pouvaient y remédier, que c'était à elles qu'ils devaient redemander leur influence perdue et les droits politiques accordés à d'autres classes; . . .[248]

In fact, academic architects' exclusive interest in the art of design and drawing was the consequence of the fragmentation of Neoclassicism in the late eighteenth century as discussed in the previous chapter. With the establishment of specialized engineering and technical schools, engineers took utilitarian aspects of design from the academic architects and became experts in scientific construction and utilitarian buildings. The realm of architects thus became limited in scope and the education of academic architects was more and more confined to the composition and drawing of monumental architecture.

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247 Léonce Reynaud,, "Sur l'organisation à donner au corps des architectes,"Journal des bâtiments et des arts et métiers (1831-32) p. 194 f. This was reprinted in the Journal du génie civil (1831)
248 Ibid., p. 291

Academic architects maintained their architecture as a higher form of art which was distinguished from utilitarian buildings. They looked down on engineers because of their use of industrial materials and their regard for efficiency and economy as the chief ends in building. As we have seen, Quatremère de Quincy even invented the notion of ideal beauty in order to preserve the primacy of the model of the Greek temple. However, Reynaud directly attacked the classicism of the Academy: By believing that only classical antiquity could give sentiment, he argued, academic architects used and consulted architecture which was made for different climates, mœurs and usage than ours.[249]

Reynaud then sought to overcome the separation of architecture into fine art and construction by a new concept of architecture which would restore the elements of construction. Criticizing the ignorance of architects in the matters of positive sciences, he argued that positive knowledge of modern sciences should be introduced into architectural education. Reynaud asked that architectural training based on drawing in the École be reformed to a more practical and technological education. He also suggested that government architects be reorganized into two classes according to their knowledge of exact sciences in order to put an end to "cette lutte entre le sentiment et la science que nous montre le passé, et qui existe encore aujourd'hui."[250] The model for his reform was indisputably the École Polytechnique which was established in 1794 as a preparatory school for engineers.

This demand to unite architecture to the scientific and technological progress of the day was persistently made during the 1830s through architectural journals. (La propriété, 1832-33, L'architecte, 1834- , Journal du génie civil, 1828-31, 1846-47)[251] Beginning in 1830 architectural journals became more numerous; between 1830 and 1834, ten journals were circulated. Echoing the call to reform after the July Revolution, architectural

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[249] Ibid.
[250] Ibid.
[251] See Lipstadt, op. cit., Chapter 4

journals of the 30s criticized the École and the Academy, demanding their reform: "La révolution de 1830 doit changer cela comme tout le reste."[252]

The architectural journals took the position that architecture was a positive science of construction, rather than a drawing of antique monuments. T. Morrisot, the editor of the La proprieté (1832-33, later, L'architecte) defined architecture as a science: "C'est une science aussi, science qui se complique d'une foule de connaissances toutes positives, que les praticiens ne doivent pas ignorer, malgré le peu d'attrait que nécessairement ils y trouvent."[253] He then criticized the Academy and the École, asking the École to put aside the antique of the Greeks and Romans and to open to *besoins*, to *usages* and to *mœurs de nôtre époque*. Morrisot also envisioned a decentralized profession and mandatory scientific education in the École. His model for reform of the architectural profession and architectural education was also the École Polytechnique. Elsewhere, Morrisot admired the engineers and the educational system of the Polytechnique:

> Nous citerons comme exemple, à ce sujet, le corps des ingénieurs qui, dans bien peu d'années s'est élevé très haut, . . . dans l'estime publique; il le doit, non seulement aux bonnes études que font les élèves, mais encore à la sévérité prudente des règlements et des épreuves auxquels on les soumet.[254]

The journals even recommended that architects should read works of engineers such as "bonne collection d'ouvrages sur la consruction comme ceux de Belidor, de Brard, de Rondelet, de Boistard, de Perronnet, . . . , de Douillot, de Duleau, de Gauthey, de Navier, . . . etc.", instead of architectural books which had beautiful drawings but no construction details. Among the government architects, only Percier and Hittorff were popular with the reformers of the 1830s. Dumas wrote in the 1832 L'Architecte:

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[252] Journal des bâtiments, "troubles à école." See ibid.
[253] "De l'étudie et de l'exercice de l'architecture en France," La propriété (30 Novembre, 1833) pp. 1-2. Quoted in Hélène Lipstadt, op. cit., p. 125
[254] "Prospectus," La propriété (décembre 1832) p. 1. Quoted in ibid., p. 127

> Les livre les plus nuisible à l'architecte, qui l'empéchent même d'avoir un talent original, sont ceux qui renferment ces collections de palais, de villes, de maisons de toute espèce, et surtout de projects. Ces livres, sans aucun détail en grand de construction, ne semblent faits que pour donner des idées sur les formes, les élévations, etc., etc., . . . L'artiste qui veut avoir un vrai talent doit proscrire ces ouvrages fatals au génie, et n'en garder que deux ou trois de ce genre, comme Letarouilly, Percier, Hittorff.[255]

The positivism in architectural journals between 1832 and 33 was clearly influenced by Saint-Simonism which emphasized the role of engineers, industrialists, artists and architects in the future ideal society. The editors of the architectural journals of the 1830s believed that art had a social function to fulfill and that "il ne doit plus se borner à un exercise frivole de l'intellegence."[256] They believed that architecture should play an important role in an ideal future society and that this was possible only by shifting the profession of architects and their education to become a more technological discipline. Thus, the journals argued for the importance of technical aspects in architecture and tried to fix the inadequacy of the anti-scientific and anti-technical education of the École.[257] As a matter of fact, architectural journals of the 30s offered technical and practical education refused by the École des Beaux-Arts. Hélène Lipstadt summarized:

> Entre 1830 et 1835 donc, toutes les revues d'architecture, . . , toutes s'ouvrent aux articles techniques, aux chemins de fer et aux accomplissements des ingénieurs, toutes se vantent d'être techniques, scientifiques et pratiques et même "positives". Chacun refuse l'exclusivisme en matière stylistique et se déclare pour la réforme de l'Ecole et contre l'architecture classique. Chacune souhaite la modernisation de la profession et le soutien des projets de réforme. [258]

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[255] Ibid., p. 129
[256] Ibid.
[257] Hélène Lipstadt, Architecte et ingénieur dans la presse: polémique, débat et conflit, Chap. 4,
[258] Lipstadt, op. cit., p.130-131

By the mid-1830s, the reform movement of architecture was thus established from both within and outside the Ecole. In 1834, in his entry "Architecture" in the Encyclopédie nouvelle (1834-36), Léonce Reynaud gave a quite accurate description of this architectural situation of the early 1830s. Reynaud wrote:

> . . . , à défaut d'autres enseignements, la marche vraiment progressive, suivie by nos jeunes architectes viendrait corroborer notre opinion. Les uns, moins serviles imitateurs que leurs maîtres, s'attachent davantage dans leurs compositions à se conformer à nos mœurs et à nos usages. Ils n'ont d'admiration exclusive pour aucun des systèmes du passé, et ils n'en proscrivent aucun. Architectes éclectiques, il ne leur est pas donné de constituer rien de plus solide que leurs devanciers en philosophie; mais archéologues savants et dessinateurs habiles, ils étudient et font connaître les différentes architectures qui se sont succédé; et leurs utiles travaux conduiront à une plus juste appréciation de l'art en mettant en évidence aux yeux de tous la marche qu'il a suivie dans son développement. Les autres se livrent à l'étude des sciences et se familiarisent avec les procédés de notre industrie; ils essaient d'appliquer artistiquement à nos constructions les nouveaux matériaux que les progrés de cette industrie mettent à leur disposition, et déjà quelques heureux résultats sont venus légitimer leurs tentatives.[259]

Socio-Technological Utopia and Iron

Under the liberal atmosphere after the 1830 July Revolution, two groups of utopians, the followers of the Comte de Saint-Simon and those of Charles Fourier, launched their campaign to build functioning communities in the real world according to the principles of their masters. The architectural ideal of Saint-Simonists was the temple, that of Fourierists, the phalanstery. Although the two groups differed in the degree to which they believed in modern science and industry, and in the conception of social harmony, contemporary iron

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[259] Reynaud, "Architecture," Encyclopédie nouvelle (1834-6) p.778

construction served as an architectural image of their utopias to both groups. With the romantic and symbolic character attached to iron, in addition to the utilitarian and industrial ones, the iron construction naturally became an important source of inspiration for their utopian architectural programs.

After the death of Saint-Simon in 1827, Enfantin, a mystic and religious figure, took the leadership of the Saint-Simonism. Enfantin emphasized the romantic and religious aspects of Saint-Simonism and preached the liberation of women and the sentiment of love rather than the positive principles of Saint-Simonism. In 1832, a group of Saint-Simonians, led by Enfantin, formed a socialist community at Ménilmontant, a suburb of Paris. At Ménilmontant, they envisioned an ideal city and a temple for their universal religion. Enfantin discussed his ideas about architecture with his Apostle, Michel Chevalier, an engineer from the École Polytechnique. In his first discourse with Chevalier in preparation for the Livre Nouveau in 1832, Enfantin already mentioned iron as a material for their architecture. In later conversation with his disciples, dealing with the nature of the ideal Saint-Simonian temple, Enfantin showed his clear interest in the use of modern materials. Enfantin's interest in iron as a future architectural material for the "synthetic phases" of history was based not only on iron's structural capacity but also its romantic character, especially, its elasticity and mobility. In a conversation with Chevalier, Enfantin said, "architecture as a theory of construction is an incomplete art: the notion of mobility, of movement, is lacking in it. ... The construction must have play, elasticity, in it. . . iron is in the first rank of materials for sacerdotal architecture." [260] By introducing regular void in the building fabric, he argued, "this would offer a temple a harmonic resonance within its very walls."[261] The idea of the iron temple was carried further by Chevalier. His dream of the temple, which was described in a poem, was clearly inspired by contemporary technological advances such as the telegraph, cast iron constructions, gas lighting and

[260] Quoted in Donald Drew Egbert, Social Radicalism and the Arts, p. 127
[261] Ann Lorenzo Van Zanten, "The Palace and the Temple: Two Utopian Architectural Visions of the 1830s," Art History, no. 2 (June 1979) p. 184

panorama.[262] However, his dream of an iron temple was also based on a highly romanticized vision of modern materials and technology. In his description, Chevalier made an analogy of the cast iron columns of the temple with the pipes of an organ, and even likened the temple itself as a musical instrument or a machine.[263] P. J. B. Buchez, another Apostle of Enfantin who later turned to Catholicism, also proposed an image of an iron temple as a musical instrument, exploring iron's capacity to aid architecture in transcending mere construction.[264] This romaticization of iron and modern technology was not unique in the romantic utopian milieu of the period.

After the failure of the Ménilmontant experiments in 1832, however, the utopianism of the Saint-Simonians turned more practical, and integrated into the capitalist economy. They believed that the facilitation of commerce and industry was essential to bring social betterment to the people; thus, they worried about the increase of production rather than distribution. Equipping the country with the means of transport and credit facilities became the chief objective of the new practical Saint-Simonism. In fact, many Saint-Simonians themselves later became famous engineers, industrialists, bankers and economists during the 1840 and 50s, and put into practice their belief in the technological progress of society.

The most paradigmatic model of the pragmatic Saint-Simonian technological utopia in the mid-1830s was railway. The railway was conceived by the Saint-Simonians as a new technological and democratic means of uniting people much in the same way as religion did in the previous ages. Furthermore, the railway was made of iron, which as a product of industry was considered a product for the future as well. The railway was the sign, and progress, the referent. Thus many Saint-Simonian engineers and bankers began to develop railways in the late 30's. Enfantin himself later became a manager of a railway company.

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262 Ibid.
263 See ibid.
264 P.J.B. Buchez, Introduction à la science de l'histoire (Paris: 1833)

The development of the railway was, in several respects, crucial in the development of iron construction. The expansion of railways facilitated the development of new industrial technologies and the concentration of production and employment in large enterprises in the iron and machinery industries. By the volume of the order and the reduction of the cost of transportation, the price of iron was significantly reduced. The construction of railways was also crucial in the development of the technology of iron construction. From the experiences with iron rails, engineers could have a better understanding of the properties of iron and more efficient sections. With the standardized parts assembled on site, the railway was also the precursor to iron girders.

Fourierists, on the other hand, whose spokesman was Victor Considérant, developed the idea of the Phalanstery as an ideal community. Considérant was also an engineer from the École Polytechnique, who converted to Fourierism in 1831. His description of the ideal phalanstery was first published in 1834 pamphlet, Considérations sociales sur l'architectonique. The Phalanstery, which was designed to house 1800 members in a single large building, was envisaged as a palace.(fig. 58) Among the major architectural motifs were a glass covered gallery and orangeries with iron roofs. These architectural motifs were clearly derived from the contemporary iron construction such as iron arcades and winter gardens.

Walter Benjamin, one of the most important theorists of modern culture, first noticed the relationship between the architectural motifs of the phalanstery and the arcades of the early nineteenth century. Arcades emerged in the late eighteenth century as a result of land speculation and the development of commerce in Paris. The wooden frames of their skylight were replaced by iron for its strength and fire resistance beginning in the early nineteenth century. "Covered with iron and glass it gave an impression of freedom and openness as though one were out of door."[265] According to Benjamin, it was a world of the *flaneur*; it was their home as opposed to the salon of bourgeois. He then wrote: "In the

[265] Giedion, Space, Time and Architecture (Cambridge: Harvard Univ. Press, 1956) p. 108

arcades, Fourier saw the architectonic canon of the Phalanstery. The Phalanstery became a city of arcades, . . . Its fading brilliance lasted until Zola."[266]

The winter garden was an artificial landscape that had been part of the life of the nobility since the Baroque period. In the early nineteenth century, the winter gardens became a part of middle class life. The nineteenth century green house was a bourgeois utopia, a desire to bring nature closer to them in modern industrialized cities. It was not intended to be a return to nature but a step toward a humanized industrialization, reconciling man with nature in an urban environment. Since the early nineteenth century, iron was used for the winter gardens for practical reasons. Utopians of the 1830s and 40s envisioned in the winter garden a social utopia for the public. In the early 1840s, Éugène Sue, a socialist novelist who was affected by Saint-Simonism and later by Fourierism, wrote a novel Les mystères de Paris (1842-43), where he first described an ideal "garden factory." While the private winter gardens were a utopia of bourgeois individualism, public winter gardens were a social utopia of collective dwelling.

The ambiguity of the forms of the technological mass culture, such as iron construction, was a central theme of Walter Benjamin's theory of modern culture. Benjamin noticed that the iron buildings for mass culture followed traditional forms although they were made of modern material of iron; arcades were planned in the form of a Latin cross and the iron facades of shops were decorated with neoclassical ornaments. Susan Buck-Morss elaborated Benjamin's discovery of the ambiquity of the arcades:

> In Arcades, on the one hand, the continuous glass roofs that became their hallmarks in the 1820s were technologically advanced sky lighting constructions; on the other, the interior walls of their shop galleries were the most derivative ornamental facades, replete with neoclassical columns, arches, and pediments that were the epitome of architectural good taste. As

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[266] Walter Benjamin, "Paris, Capital of the Nineteenth Century," Reflections, ed. by Peter Demetz New York: Schocken Books, 1986) p. 148-9

> dialectic images, the arcades thus had a hermaphroditic position, fusing the two tendencies which elsewhere developed in total, and hostile, isolation.[267]

Although the iron buildings were mixed with traditional tastes, Benjamin argued that these new buildings of iron, as a source of dialectical imagination, had an instant of utopia which had its store place in the collective unconscious.[268] As buildings for use rather than for contemplation, such structures were spared from the self-conscious meditation of art and settled into the collective imagination in an unconscious form. Benjamin argued that the iron buildings thus could awake the utopia in the collective unconscious. This utopian ideal was manifested most clearly in the public iron halls which later appeared in the mid-1840s, such as railway stations, public winter gardens and market halls. While iron arcades and cast iron elements provided in a highly romanticized way a hint at the image of a universal temple and a collective dwelling under covered iron roofs in the early 1830s, the new types of iron public halls which emerged in the mid-1840s were themselves an image of social utopia, a utopia of mass democratic society, or the association of people.

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[267] Susan Buck-Morss, op. cit.

[268] See Walter Benjamin, op.cit., p. 148

Chapter Five: Rationalist Doctrines for a New Style of Architecture and Iron Construction, 1834-45

> Voici un programme nouveau, un programme du XIXe siècle: un jardin sous verre! . . ; les poètes, les utopistes, les rêveurs des siècles écoulés sont dépassés par les réalités de cette année 1847. Aussi, les moyens employés sont-ils essentiellement les moyens de notre temps; c'est l'industrie moderne qui les a fournis: c'est le fer, la fonte et le verre.
>
> César Daly, RGA, 1847

Formation of Rationalist and Historicist Doctrines of Architecture, 1834-45

Beginning in the mid-1830s, a group of Saint-Simonian architects, engineers and critics and Romantic architects, who had challenged the classical doctrines of the Academy and the Ecole des Beaux-Arts in the early 30s, launched their collective effort to develop a new doctrine of architecture based on a historicist, functional and structural concept of architecture. Among them were Léonce Reynaud, a Saint-Simonist architect-engineer, Hippolyte Fortoul, a Saint-Simonist critic, and Romantic architects such as Léon Vaudoyer and Albert Lenoir. The group of Saint-Simonians who were involved in developing the new doctrine of architecture, were dissidents who had abandoned the sect when Enfantin took leadership in 1831. However, they remained faithful to the basic tenets of the Saint-Simonian movement: "the inevitability of evolution and progress in all human institutions; the primacy of science and industry in the modern age; the need for society to reorganize itself in response to this development."[269] Against Enfantin and his followers' quasi-religious doctrine of Saint-Simonism, they dedicated themselves to a direct engagement in social issues and current politics, trying to disseminate the Saint-Simonian doctrines in the form of books and periodicals. Their pivotal project was the publication of the

[269] Van Zanten, Designing Paris, p. 46

Encyclopédie nouvelle (1834-). Jean Reynaud, a younger brother of Léonce and a Saint-Simonist engineer from the Ecole Polytechnique, and Pierre Leroux, a Saint-Simonist critic, commenced the project in 1833, in a belated response to Saint-Simon's request to lay the foundation for rational, scientific society of the future. The architecture entries were assigned to Léonce Reynaud, who led the reform movement of the Ecole since the late 1820s, and later, Léon Vaudoyer, a Romantic *pensionnaire*, came to help.[270]

In the Encyclopédie nouvelle, Léonce Reynaud laid down a ground for their new concept of architecture. Reynaud's entries "Architecture," and "Brunelleschi" published in 1834, especially served as a kind of manifesto of their doctrine. In "Architecture," Reynaud defined architecture, demonstrating his functional and structural concept of architecture: "toutes les constructions élevées par la main des hommes font partie du domaine de l'architecture."[271] This definition of architecture was a complete overturn of Quatremère de Quincy's, laid down in his Encyclopédie méthodique, published from 1788 to 1825, and the Dictionnaire historique d'architecture of 1832. There he defined architecture: "C'est l'art de bâtir suivant des proportions et des règles déterminées."[272]

In his subsequent architectural entries in the Encyclopédie nouvelle, Reynaud systematically deconstructed the classical architectural elements such as Orders and proportions as scientific and technological facts.[273] Beauty was also explained as a physical manifestation of technical knowledge and of the institution that the structure embodied. In "Brunelleschi," Reynaud wrote,". . . dans sa manière de voir, la forme devait être une conséquence naturelle des nécessités de la construction; le beau ne pouvait être que la manifèstation du bien."[274]

Reynaud devoted much of his writing in "Architecture" to history. His concept of history was clearly influenced by Saint-Simonians. In 1830, Émil Barrault (1799-1869), a

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270 Ibid.
271 Reynaud, "Architecture," Encyclopédie nouvelle (1834-6) p. 770
272 Quatremère de Quincy, Encyclopédie méthodique, vol. 1 (1788) p. 109
273 Especially see "Colonne," Encyclopédie nouvelle (1834-6)
274 Reynaud, Encyclopédie nouvelle , p.98

poet and a disciple of Saint-Simon, had published a pamphlet Aux artistes: du passé et de l'avenir des Beaux-Arts, where he presented the Saint-Simonian view of the history of civilization as a cyclic development, alternating between organic and critical phases. Three years later in the preface to the sixtieth volume of the Revue encyclopédique, (1833), Pierre Leroux had presented a modified view of the Saint-Simonian concept of history as "continuing progress".[275] Writing in 1834, Reynaud basically adopted their concept of history to architecture. His history of architecture, however, was not concerned with styles; it was devoted instead to the science of building. Reynaud's earlier thinking of architecture, functional, positivistic and technological, was thus strongly present in his analysis of architectural monuments of the past. He wrote:

> . . . tout monument d'architecture doit non seulement être utile, mais encore porter franchement l'empreinte de son utilité. C'est là une condition nécessaire à l'existence de l'art. . , mais ce n'est pas la seule. La forme générale d'un édifice ne résulte pas seulement de la destination de cet édifice, elle dépend aussi de la nature des matériaux employés dans la construction, des lois qui régissent la matière et du mode de construction adopté. Ces données influent sur le nombre et la disposition des points d'appui, sur les rapports existants entre les pleins et les vides, entre les supports et les parties supportées, et sur les formes des parties, dont la réunion constitue l'édifice. De sorte que les connaissances d'un peuple sur les lois de la nature et sur le meilleur mode d'action de l'homme sur la matière doivent exercer une grande influence sur son architecture.[276]

Reynaud then traced the development of structural forms, which he saw to be a progressive evolution, from the heavy weight, narrowly spaced stone lintel of Celts, Indians and Egyptians, to the more elegant Greek arrangements, and thus to the introduction of the arch by the Etruscans. He argued that the progress of architecture was

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275. See Robin Middleton, "The Rationalist interpretation of . ..", p. 41

276 Reynaud, "Architecture," Encyclopédie nouvelle, 770

dependent upon the developmental stages of science and industry of society. But, Reynaud also qualified his position, maintaining that the positive factors did not determine the form and the composition of the *parties*, but only gave approximations and limitation. An architectural form, he argued, was ultimately given by general moral ideas and the beliefs of the society. This was the reason why, after Christianity had lost its authority, the European society went back to the architecture of an earlier period as a more appropriate form of expression for new ideas.

Reynaud strongly believed in the organic unity of a civilization and thus, in the correspondence between scientific and industrial progress, and spiritual and sentimental aspects of the society. Architecture reflected a civilization precisely in this interdependence of matter and spirit, "dans cette triple empreinte d'art, de science et d'industrie."[277] He wrote:

> En résumé l'architecture est un art sur lequel la science et l'industrie exercent immédiatement une grande influence, puisqu'il leur doit ses moyens d'existence et une partie de son expression; et c'est précisément dans cette dépendance de la matiére et des lois qui la régissent, dans cette triple empreinte d'art, de science et d'industrie, qu'elle puise son caractère particulier. . . Il existe, en effet, une certaine relation entre les usages, les connaissances et les sentiments de l'humanité aux diverses périodes de son développement. Cette relation constitue une sublime et mystérieuse harmonie, qui est marquée sur tous les travaux de la main de l'homme; . . Les sentiments, les connaissances et les usages se traduisent dans nos édifices par la décoration et les proportions, par la nature et l'emploi des matériaux, par le nombre et la distribution des pièces; la richesse et la grandeur des monuments représentent d'ailleurs la puissance et l'industrie de la nation qui les a élevés. Ainsi, que la distribution soit conforme aux exigences des coutumes, que les procédés de construction soient tels qu'ils sont indiqués par la science, que *les proportions et le mode de décoration découlent naturellement des sentiments et du goût de l'époque, et le*

[277] Ibid., p. 771

système d'architecture qui en résultera aura le privilège et la puissance de représenter la societé sous toutes ses faces.[278]

Therefore, Reynaud also argued that a past architectural system could not have an absolute value; one needed to study historical styles only to create a modern architectural system based on modern science and industry:

> . . . si tout système d'architecture correspond à un certain état de la science humaine et en est une conséquence, il s'ensuivra directement, puisque notre science est essentiellment variable et progressive, qu'aucun des systèmes du passé ne peut être considéré comme ayant une valeur absolue. . . . Les societés modernes, avant de se créer un nouveau système d'architecture, avaient dû examiner ceux qu'avaient suivis nos pères pour en vérifier la valeur et en étudier les lois.[279]

Strongly influenced by Saint-Simonian belief in the progress of humanity, Reynaud was confident that a new modern architecture befitting modern society would eventually emerge because ". . . il existe une connexion intime entre les destinées de l'humanité et celles de l'architecture." [280] He concluded his article:

> . . . toutes les fois que les hommes seront réunis au nom d'une grande idée morale, ils mettront nécessairement le lieu de leur réunion en harmonie avec l'idée; et que des progrès de la science et de l'industrie dépendent encore d'autres progrès de l'architecture. . ; et si l'humanité doit continuer à s'élever, l'architecture, ce grand art où elle se réflète sans cesse, lui sera fidèle et saura s'élever avec elle.[281]

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278 Ibid., pp. 771-772, my italic.
279 Ibid., p. 778
280 Ibid.
281 Ibid.

The rationalist interpretation of architectural history was carried further by Léon Vaudoyer, Reynaud's collaborator in the Encyclopédie nouvelle, and Hippolyte Fortoul, a Saint-Simonian critic and one of the Encyclopédie's major contributors. Beginning in 1839, Vaudoyer wrote a series of articles, "Etudes d'Architecture en France" with Albert Lenoir for the Magasin pittoresque(1839-54), which he founded in the same year.[282] The second major theorist Fortoul, the only non-architect among the group, often traveled with Vaudoyer as well as with Edouard Charton and Louis Duc into the environs of Paris and to England and Germany during the late 1830s. Then, Fortoul wrote two volumes of De l'Art en Allemagne, published in 1841 and 1842.

In their writings, Vaudoyer and Fortoul interpreted architectural history as a dialectic progress of structural forms from the rectangular, such as the post and lintel, associated with Greco-Roman society, to curvilinear, such as arches and vaults, associated with Christian culture. Fortoul focused his research particularly on transitional periods in the history of architecture, such as the Byzantine and the early Renaissance, when attempts were made to impose ordering system on curvilinear architecture. Fortoul then predicted a new system of modern architecture as one that was based on the round arch but with a system of coordinated relationships similar to those in the Greek Orders.[283]

David Van Zanten well summarized the doctrines these three theorists in the following way: "The basic concept of the "doctrine" produced by Reynaud, Fortoul and Vaudoyer is that architecture is the structural envelope of a social institution and so expresses that institution in its form, changes with it, and evolves as technical knowledge becomes more sophisticated."[284] However, Van Zanten seems to have overlooked a difference between Reynaud and other critics in their program for modern architecture. Vaudoyer and Fortoul launched a systematic study of history of architecture with a renewed

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[282]Middleton argued that these articles were actually written by Lenoir rather than by Vaudoyer, relying on the fact that their content was so close to the manuals of the *Comité des Arts*, which Lenoir wrote in 1839. See Middleton, "The Rationalist interpretation..."

[283] See Fortoul, De l'art en Allemagne, vol. II (Paris: Jules Labitte, 1842) p. 323

[284] Van Zanten, Designing Paris, p. 56

interest in the structural principles, and this, they believed, would eventually lead to the discovery of a new modern system of architecture for their time. Their search for the new modern architectural system, thus, was conducted within the limit of the historically given structural forms such as arches and vaults, that is, the historical process of transformation of the structural forms. They envisioned a modern system of architecture purely in the historical transformation of these structural forms and geometrical principles. In their theories of modern architecture, therefore, there was little space for modern industrial products and new constructional technology to intervene: Although iron construction was employed in their buildings as a fire resistant construction, the new material could not take a formal and stylistic significance; neither was it considered a distinctive structural principle for future architecture.[285]

The historicist doctrine of Fortoul and Vaudoyer, however, was ineffective in creating a new architectural system, as the works of the Romantic *pensionnaires*, such as Duc's Palace de Justice and Vaudoyer's Marseilles cathedral, later proved.(figs. 59, 60) Although these Romantic architects returned to the basics of structural and physical reality of architecture, rejecting classical idealism, by ignoring the products of modern science and industry, they ended up with archeological eclecticism which neither incorporated modern science and industry, nor created a novel structural system. As a result, by the mid-nineteenth century, more specifically between 1847 and 1853, expressive tendencies of romantic individualism revived among the École students, which Vaudoyer condemned in the Magasin pittoresque, naming it *architecture parlante*. [286]

Reynaud, on the other hand, gave more weight to modern science and industry. As he wrote in "Architecture", he believed that a modern system of architecture would emerge by applying the products of modern science and industry to modern programs of architecture in the way that ancients had used science and industry available to them.[287]

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[285] Duban's École des Beaux-Arts and Duc's Palace de Justice used iron roof system

[286] See Neil Levine, op cit., p 405

[287] In fact, criticizing the use of the iron reinforcement in Neoclassical architectue, he implied a rational use of iron for modern architecture. See Reynaud, "Architecture," in EN, col. 778

Thus, while teaching as Professor of architecture at the École Polytechnique beginning in 1837, Reynaud continued to search for the possibility of iron construction, and himself built several iron constructions, including the lighthouse at Heaux de Bréliat in 1834-39 and later, the Gare du Nord (1843-46). (figs. 61, 62)

At this point, it should be mentioned that among the works of the Romantic rationalists, only Henri Labrouste's Bibliothèque Ste.-Geneviève, which was designed in 1839, approved by the Conseil Générale des Bâtiments Civils in 1842, and built between 1843-1848, stood out as an isolated case in which the product of modern industry was successfully incorporated into the romantic rationalist concept of architecture.(fig. 63, 64, 65, 66) The Bibliothèque Ste-Geneviève was the first public monumental architecture where iron construction was employed as a visible structural elements. While the significance of iron structure in the library was noticed by many modern critics and historians, their account of it was largely based on the simplistic evolutionary view of the modernist historiography as discussed in the Introduction. For example, Giedion praised the machine aesthetic quality of the library, writing "Labrouste's chief accomplishment in this library rests in the manner in which the iron is balanced in itself, so that it puts no stress on the wall."[288] However, since "thick masonry walls still remain," Giedion considered the library as a sort of proto-modern architecture. Recent studies on Labrouste's architecture, on the other hand, especially by Neil Levine, focused on what he argued Labrouste's modernization of the Beaux-Arts principles. Levine argued that what was revealed in every form and detail of Labrouste's library was Néo-Grec principle of decoration of construction.[289] However, this time the significance of the use of iron in

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288 Giedion, Space, Time and Architecture, p. 218-228

289 See Neil Levine, "The Romantic Idea of Architectural Legibility: Henri Labrouste and the Neo-Grec," Architecture of the Ecole des Beaux-Arts. and "The Book and the Building," The Beaux-Arts and Nineteenth Century French Architecture, However, I have fundamental questions to his interpretation of Labrouste. Levine uncritically accepts the continuity between Labrouste's architectural thinking of the 1830s and the so-called Neo- Grréc idea of the 1860s and 70s. That is, he tended to see the library and the architectural principles laid bare in it as a beginning of the modernization of the Beaux-Arts architecture which would appear in the latter part of the nineteenth century. Levine argues that the Neo-Gréc idea of the 1860s and 70s, that is, the separation of structure and decoration and the idea of historicity of architectural styles, was prefigured by and in fact was the crux of Labrouste's architectural thinking in the 1830s. However, I

Labrouste's library was treated with triviality. Neil Levine's majestic works on Labrouste certainly downplayed the importance of the use of iron in Labrouste's library and "socialist utopian thought in the evolution of Labrouste's conceptions".[290/291] I would argue that Labrouste's library should be understood as a materialization of his thinking of the 1830s, that an architectural form should be derived from the construction, material and program. As discussed in the previous chapter, in stressing that the material and construction should be expressed in form, Labrouste's concept of architecture was already distinguished from the idea of "structural organism" of other Romantic *pensionnaires* such as Duc and Vaudoyer.[292] Thus, Labrouste was more perceptive to the development of new material and construction of the day than other Romantic rationalists and used iron in his building while other Romantics did not. Labrouste's use of iron also reflected his affiliation with technological utopian thought which was associated with iron construction. While he used

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believe that Levine's premise raises several questions which are difficult to answer. First, the principle of separation of structure and decoration, which Levine argued to be the essence of Labrouste's thought, was not certainly originated from Labrouste. It was already found in the early nineteenth century development of type (1800-30); that is, in consumer eclecticism of Percier, Fontain and Lebas, and utilitarian buildings of the 1830s.(See Anthony Vidler, "The Idea of Type" in Oppositions 8) Second, I believe that there is an ambiguity in the attempt at establishing the concept of neo-Gréc as a general architectural principle which would embrace many contradictory tendencies as such stylistic concepts as Neoclassicism and modernism do. In reality, it is not clear whether the concept of neo-Gréc refers to a style, sprit, or principle.
Third, since Levine saw the library as the beginning of the neo-Gréc, he interpreted the library and the iron reading room from an illusionist point of view of neo-Gréc principles. Levine's illusionist interpretation of the library, that is, an elevation of a mechanical construction to an imaginative space, was too much based on the later nineteenth century view of Labrouste. During the 1870s and 80s, a fantastic, symbolist and illusionist view of architecture was in vogue. Levine based his interpretation of Labrouste heavily on the view of Nicolle, a rationalist and illusionist around 1887. I believe that Labrouste's library is not yet neo-Gréc in the sense that Levine theorized. There was neither illusionism, nor abstraction in his design of the library. Labrouste used iron above all for constructional honesty and for the economy that he valued most in architecture, not for fantasy and illusion. Labrouste himself wrote of very practical reasons for the use of iron. Perhaps, the idea of illusionism may be applied better to the iron structure of the salle de imprimes of the Bibliothèque Nationale built by Labrouste in the1860s. Therefore, I would argue that Labrouste's library can be seen as a monument of the 1830s aspiration to create modern archtiecture, and not as a starting point of the Beaux-Arts eclecticism of the second half of the nineteenth century as Levine argued. The Neo-Gréc was clearly a late nineteenth century phenomenon, which appeared when the impossibility of creating the architectural style based on material and constructional rigor was manifested.

[290] Neil A. Levine, Architectural Reasoning in the age of Positivism: The Neo-Grec Idea of Henri Labrouste's Bibliothèque Saint-Geneviève, (Ph. D. Dissertation, Yale Univ., 1975)

[291] Robin Middleton, The Beaux-Arts and Nineteenth Century French Architecture, p. 6

[292] Labrouste already distanced himself from other Romantic pensionnaires. For this, see Van Zanten, Designing Paris. As Van Zanten pointed out, Labrouste was conspicusly absent among the group of Romantic historicists of the 1830s. And Duc was in fact critical of Labrouste' use of iron in the vestibule of the library. See Levine, " Romantic. . ." p. 348

cast iron columns and vault innovatively in the iron floor system and the reading room of the library,[293] the stone facade of the library demonstrated his rational, historicist understanding of architectural forms. The stone envelope was a rational structure standing on its own-- an arcade; here, not only classical but also any historical styles were rejected as a reference of meaning. Labrouste's decoration of the wall of the library with the names of authors and scientists in 1848 confirmed his susceptibility to mass cultural, rather than classical, means of communication and the positivist belief in the future. Therefore, it could be argued that Labrouste's library was a successful synthesis, more than Reynaud's Gare du Nord, of the two major theses of the program for modern architecture that Reynaud laid down in his "Architecture": that is, adoption of modern industry and the rational interpretation of architectural history.

In searching for a new style of modern architecture, architectural journals played no less significant a role. The technological discourses of architecture which appeared in the architectural journals of the early 1830s took a more systematic discursive format with the publication of Revue générale de l'architecture et des travaux publics by César Daly, a Fourierest architect. César Daly received an engineering education at the École Polytechnique at Douai and then pursued architectural study at the *atelier* of Félix Duban. In the revolutionary years of 1830, he became a devoted disciple of Fourier and participated in projects for phalanstery. But rather than pursuing evidently hopeless communal projects of the utopians, Daly chose to publish Révue générale de l'architecture et des travaux publics in 1840, as a written instrument for social betterment. The goal of the journal was to disseminate knowledge to enhance the progress of science for social good.

In his journal, César Daly maintained the positivistic position that architecture is *l'art de bâtir* whose progress depends on the progress of science and industry. As a

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[293] His skillful and innovative use of iron floor system as a docorative element distinguished himself from other constructors.

utopian socialist, he also strongly believed in the progress of humanity. Daly started his first editorial of the RGA , defining architecture in this way.

> Lorsqu'on se rappelle que les ingénieurs et les architectes sont chargés de présider aux constructions qui abritent les hommes, les animaux et les produits du sol, que ce sont eux qui élèvent ces miliers d'usines et de manufactures où s'exerce une si prodigieuse industrie, ces villes immenses décorées de splendides monuments, . . que ce sont eux qui facilitent les communications des peuples entre eux pas la création des routes et des canaux, ... quand on réfléchit à l'immense utilité, à l'absolue nécessité même de ces entreprises aux millions qu'elle occupent, on est naturellement conduit à apprécier l'importance de la science à laquelle on doit ces merveilleuses créations, et à sentir que ses moindres progès intéressent tous les pays du globe.[294]

His major intention in the publication of the RGA was then to multiply experiences and to exchange knowledge of scientific and technological innovations, in order to advance the science. Daly wrote: "Pour faire avancer la science aujourd'hui, il faut donc surtout multiplier les expériences; il faut les réunir, les porter à la connaissance de tous: mais ceci suppose des rapports habituels entre les ingénieurs, entre les architectes, et entre les uns et les autres; rapports qui n'existeraient que si les ingénieurs et les architectes étaient régulièrement organisés."[295] However, Daly criticized the actual state of separation between architects and engineers. Although government architects and engineers had their own organizations, there was no intimate relationship between the two groups. Daly wrote, ". . . les ingénieurs et les architectes du governement, chacun dans sa spécialité, ont bien un centre où leurs projets vont se réunir pour être discutés; mais l'action de ce centre se borne à peu près à cet examen. Quant aux architectes et aux ingénieurs civils, ils sont parfaitement isolés les uns des autres."[296] Since the Academy and the École des Beaux-

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[294] César Daly, "Introduction," RGA (1840), col. 1
[295] Ibid., col. 3
[296] Ibid.

Arts were still in the hands of traditionalists and the teaching of science and technology was rejected in the École, the Révue générale de l'architecture et des travaux publics was intended to serve as an instrument to bring together all the innovations made by engineers and architects. His magazine, thus, actually introduced many technological inventions, such as new systems of iron construction, scientific studies of materials and other technical advances in heating, lighting and ventilation systems during the 1840s. The first volume of the RGA, for example, introduced the Polonceau truss, and all new iron beams and floor systems frequently appeared in the subsequent issues.(fig. 67) Linking architects and engineers in a positivistic way, Daly vowed to show the intimate correlation which exists between art and science. He wrote: "Nous montrerons la corrélation intime qui existe entre la *science* et l'*art*, qui concordent comme deux vérités doivent nécessairement le faire, comme doivent le faire deux conséquences logiques d'un principe vrai."[297]

In addition to scientific and technological innovations, Daly also included historical and archeological studies as important knowledge to be included in his journal. Like the Romantic and Saint-Simonian architects and critics, he believed that the scientific study of history could reveal the natural laws of architectural development, which could help to create a new style of modern architecture. Presumably, Daly assumed that the principles of the transformation of architecture which were to be found through rational studies of history, could somehow be consistently applied to modern science and industry and new social needs of modern society. César Daly wanted his journal to be a forum for the exchange of advanced knowledge in various fields related to architecture. He made this clear in his first editorial, stating that the *Revue* would address itself simultaneously to architects, engineers, archeologists, industrialists, proprietors, and finally, to governments.[298]

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[297] César Daly, "Introduction," RGA (1840), cols. 4-5,
[298] See Ibid., col.4

Henri Labrouste, a leader of the anti-academic movement of the 1830s, joined the RGA from the beginning. As already discussed, Labrouste shared with Daly the belief in the unity of construction and architecture and thus, the necessity of incorporating modern material and technology into architecture. Labrouste designed the cover of the journal, which in effect symbolized his and the journal's common ideal, and frequently contributed to the journal.(fig. 68) In the first issue of the RGA, for example, Labrouste wrote a review of the Ecole's educational system, criticizing the separation of construction and architecture.[299]

Structural Innovation and Formal Expression

While iron was more frequently used in architecture after 1840, especially with the development of railways and the modernization of iron industry, there was no immediate specific concern for style in its use. Iron construction was not discussed in terms of its formal expression, or of a new style of architecture for the future, until the mid-1840s. Until the early 1840s, iron was still conceived basically as a new material and a new genre of construction which would replace parts of traditional wood and stone elements with its superior material qualities and its economic advantages. Iron structural elements were concealed in most cases, and when cast iron elements were used for visible parts, they were only reproducing neoclassical and eclectic forms. Architectural books on iron construction published during the early 1840s, such as Eck's and Thiollet's, and architectural journals during the same period gave evidence of this. Iron buildings which were built entirely of iron such as winter gardens, factories, markets and warehouses, on the other hand, were still considered by the Academy and the École to be mere utilitarian buildings, a lower genre in the Academic hierarchy, which had little to do with an architectural style per se.

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[299] See RGA, vol. 1 (1840) p. 58

Although Daly was interested in the products of modern science and industry, and promoted their use through publication, iron was not considered an agent for the future architecture. His interest was in technical innovations of iron construction, processes of production, and the efficiency and economy of construction - without considering formal aesthetics. As previously discussed, his idea of modern architecture was fundamentally based on the romantic and positivistic, if not encyclopedic, belief that the modern technological and scientific progress would naturally embrace art.

The dominant style of architecture of that time was of course neoclassicism, especially that of Durand, rather than Quatremère, which had been used by engineers and architects after the Revolution because it best fit programs of civic architecture and their demand for rationality.[300] With the emergence of romantic tendencies in arts in the 1820s, the liberal classical school of Percier and Fontaine, and Jacques Ignace Hittorff tried to make their classical architecture to be modern by freely using historical motifs and the modern technology such as iron construction. However, their effort to renew architecture remained within the iconographic concern of neoclassical theory of architecture, which was epitomized by the theory of "character", an appropriate formal expression of a building's function. The structure and construction technology were not for expression. As Schneider states, for the Academy and Beaux-Arts architects, "the primary role of structure was to shelter function and that which elevate mere structure to architecture is the function sheltered rather than formal expression of the materials or methods employed."[301]

However, formal expression of material and structure could indeed become an issue when an exposed iron structure was used innovatively in the buildings for a completely new program. This was the case with the Panorama which was designed by Hittorff between 1838 and 1839. Throughout his career, Hittorff made many technological innovation in iron constructions. However, in most cases, as discussed earlier, he blended

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[300] Durand, Bruyere and Mandar's books were a proof of engineers' loyalty to neoclassicism until 1830s.
[301] Schneider, Donald David, The Works and Doctrine of Jacques Ignace Hittorff (Ph. D. Dissertation, Princeton Univ., 1970) p. 462

the technological innovations with formal principles from classical antiquities. For example, in his Cirques d'été (1839-41), Hittorff designed a roman temple portico for the iron roof, subordinating the structural materials to the functional utility and thus to formal expression. Despite their daring structural innovation, thus, his building was assimilated to the ancient building type of Roman theater.(fig. 69) However, the panorama was a completely new function, a modern invention that had never existed before. Like the developing railway stations at that time, it was new civic architecture that did not fit easily in any category of ancient architectural program, and was thus less susceptible to traditional formal expressions. As Schneider well pointed out, "[I]n all its aspects, the Panorama as an architectural problem involving antithesis between traditional expression and both functional and structural innovation is as unique to the period as were the train sheds that made their first appearance after 1835."[302] While early railway stations in the early 1840s were designed in Italinate style, Hittorff determined to express the function and structure of the Panorama to the exterior. As a completely new architectural program developed out of modern technology, he did not want to compromise the antithesis of internal function and external design with symbolically expressive motifs from antiquity. All that was functionally necessary in the Panorama was a circular wall to support the cyclorama and an interior design to support the perspective illusion for centrally located viewers. Hittorff wanted to express the functions to the exterior without hiding the solid wall behind rows of windows as if the structure were merely a group of habitations in a circular plan. [303] (fig.70)

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302 Schneider, op. cit., p. 435

303 Hittorff, J. "Description de la Rotonde des panoramas, élevée dans les Champs Elysées, précédé d'un aperçu sur l'origine des panoramas et sur les principales constructions, auxquelles elles ont donné lieu, " Revue générale de l'architecture II, 1841, col. 559. This article was published separately in 1842 and translated into English in a 49 page MS (11 July 1842) RIBA

"Il fallut, dans un édifice destiné primitivement à un seul usage, l'exposition de panoramas, et dont le mur circulaire, couvert intérieurement de la toile panoramatique, devait ostensiblement annoncer la destination, il fallut que ce mur disparût derrière une suite de croisées lesquelles ne pouvaient donner l'idée que d'habitations distribuées dans un bâtiment de forme circulaire, la plus opposée à une pareille distribution." col. 559

To the roof of the Panorama, Hittorff applied a suspension system which was first used in the bridge at Sequin in 1823.(fig.41) His design of suspension roof system was a rational, functional and novel structural innovation to solve the problem of roofing a building which required a grand diameter for its rotunda. On the economy of the suspension roof system, he wrote in the Description de la rotonde des Panoramas, élevée dans les Champs-Elysées,". . .presque illimité pour etendue des espaces qu'il peut couvrir, il donne autant de certitude de durée que tout autre genre de construction base sur l'emploi du fer, en même temps qu'il peut se concillier avec des dépenses proportionallement peu élévée."[304]

Hittorff intended to express his technological innovation to architectural form as well: As he later wrote, his intention was to make an "architectonic form with an industrial construction rather than monumental." After reviewing Hittorff's design, the Conseil Générale des Bâtiment Civils demanded to change the design of roof system for practical reasons. However, as Hittorff argued, there was in fact no structural advantage in lowering the iron struts. The real underlying motive of the Conseil's demand was obviously a monumental form. In response to the Bâtiments Civils' request to change the design, Hittorff thus complained that the change would hurt his original design intention without a structural advantage:

> . . . d'abaisser le point d'appui des cables et d'en répartir la charge verticalement sur la mur . . i.e. son adoption me faisait perdre. . . la faculté d' appliquer mon système de suspension de manière à obtenir des formes architectoniques avec un moyen de construction plus industriel que monumental, il s'agissait surtout de prouver qu'il n'y avait aucun avantage à satisfaire à cette demande.[305]

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304 Ibid., col. 560

305 Ibid., col. 558. Comparing Hittorff's Panorama and theaters with his later Gare du Nord (1846), Schneider stated that it was an irony that the Gare du Nord was criticized by Anatole de Baudot from the exactly same point as that Hittorff criticized the Conseil in defense of his Panorama. However, Schneider was not clear in the first place why there were such changes in Hittorff's design between the Panorama and the Gare du Nord, while both buildings were noble functional and technological construction. I believe that as I will argued in the later chapters there was a change of situation before and after around 1850. Before

However, Hittorff's intention to express the architectonic form with industrial construction could not survive the Conseil des Bâtiments Civils' demand for a monumental form disguised with pragmatic reasons, and more importantly the promoter Charles Langlois' concern about commercial necessities. Hittorff finally changed his novel design to the Italinante elevation which was customary not only for theater facades, but also for the then generally accepted formal expression for the new genre of railway stations.[306] (figs. 71, 72, 73) In the end, Hittorff's original design, which had intended "an architectonic form with industrial means of construction," changed to an academic and monumental building. As Schneider stated, ". . . in reaching a compromise with his original, functionally and structurally expressive design for the Panorama's exterior, . . . Hittorff was forced to adopt a more academic formulation, reminiscent of both a Bramantesque courtyard elevation and his own theater facades of the 1820s."[307]

What the case of the Panorama tells us was that the formal expression of material and structure were not yet acceptable within the frame of neoclassical theory of architecture. In the neoclassical theory, architecture was communicated through the formal expression of the function of the buildings, that is, the expression of formal "character." Therefore, the new material and structure could not emerge as a determining factor in producing a formal language in the classical theory of architecture. A technological innovation in architecture had to compromise with the contemporary taste and had to express itself through conventional types.[308]

1850, there was a positivistic belief in the unity of art and industry and positivistic concept of art whereas after 1850 during the Second Empire, things changed, and art and industry were completely separated. Therefore the 1830s and 40s' positivism was very different from the rationalism during the Second Empire.

[306] Schneider, op. cit., p. 453

[307] Ibid., P. 452

[308] Labrouste's Bibliothéque Ste-Geneviève, completed in 1850, was also crticized by architects for lacking "character" as a library. The critic F. Barrière wrote in the Journal des débats (Dec. 30, 1850): "to each building, a style, a character, forms in relation to its purpose." And Achille Hermann wrote in L'artiste ser 5, vol. 7 (1851):" The character of a building cannot be measured only by its purpose: the idea it represents in the eyes of the public is part of it, the esential part of ir. . . Is it that the artist failed to endow his creation with the grandoise character that so great a program demands? This is what, I think, the public

By the early 1840s, however, rationalist interpretation of architecture and history was established. Although most Romantic rationalist architects and critics searched for a new form within the limit of the structural forms found in history, and did not pay particular attention to iron and the new construction technology, their concept of progress of architecture and history played a significant role in freeing architecture from conformity to the eternal past of classical antiquity and thus, to provide the possibility for new architectural style. With the development and increasing use of iron construction in the 1840s, thus, a liberal environment was provided, where iron could emerge as an active agency to create a new style of architecture.

Already in the early 1840s, liberal architects began to notice the potential of iron to create a new form. In the 1841 Revue générale de l'architecture, Félix Tourneux foresaw a fundamental change in architectural form that the new element of iron would bring about. Citing the advances made in iron construction, such as iron bridges, iron floor and roof frames and cast iron columns, Tourneux proclaimed the arrival of a new form of architecture:

> De cette pensée féconde sont nés les ponts fixes en fonte ou en fer forgé, les ponts suspendus, les bateaux en fer, les légères colonnettes qui remplacent avec avantage les lourds pilastres, . . . les magnifiques charpentes dans lesquelles on remplace par le fer et la fonte, les forêts de bois qui servaient à la couverture des grands édifices. Il est impossible de douter, à la vue de ce nouvel élément si largement introduit dans l'architecture, que cet art ne soit appelé, dans un avenir prochain, à subir des modifications profondes; et peut-être . . . trouverait-on dans ce fait la haute raison philosophique qui semble rendre le génie des inventeurs de notre siècle si peu fécond à produire de *nouvelles formes*. Qui pourrait croire, en effet, que l'art soit éternellement destiné à tourner dans le cercle des formes connues sous le nom de grecques, romaines, gothiques, renaissance, XVIIIe siécle, etc. [309]

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instinctively reproaches him for." p. 130-1 (Translated in Levine, "The Romantic idea of Architectural Legibility: Henri Labrouste and the Neo-Grec," Architecture of the Ecole des Beaux-Arts, p. 347-8)

[309] Felix Tourneux, "De l'emploi de la fonte et du fer forgé dans les constructions," RGA (1841) p.418

The new forms of iron architecture, however, were yet conceived with reference to the existing historical styles. Paradoxical as it may seem, the architectural style which was first and most often associated with iron was the Gothic. The new iron architecture was expected to resemble the Gothic style. As I have already discussed in chapter two, fineness and linearity of cast iron elements had been affiliated with Gothic style more than any other style from the inception.[310] In his article, Félix Tourneux, although he argued for a new form of iron architecture, also confirmed the commonly held affiliation between the Gothic and iron, saying that, ". . . de toutes les formes anciennes, celle qui parait devoir se prêter le mieux à l'emploi de la fonte, c'est sans contredit l'architecture gothique."[311]

The interest in Gothic architecture in the early nineteenth century originally stemmed from the romantic interest in the picturesque during the early nineteenth century. Gothic cathedrals which had been abandoned during the revolutionary period, began to be restored after the Restoration in 1815. However, with the rise of romantic eclecticism after 1830, interest in the Gothic in France soon changed from the merely picturesque to a serious sentiment for the Gothic as a national architectural style.[312] Although interest in Gothic was part of romantic eclecticism and had an anti-industrial connotation as well, there was also a strange mixture of past and modernity in Gothic revivalism. The modernity of the Gothic was partially linked to the use of iron in the restoration of Gothic churches. While iron was used mostly as reinforcing materials, such as cramps and tie rods, cast iron elements, which had been employed in commercial buildings as both structural and decorative elements, were also used experimentally in the restoration of Gothic cathedrals. The most frequently used cast iron elements in the Gothic restoration were columns, towers

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[310] In fact, the honest structural expression of Gothic architecture had been associated with slender iron construction since its inception, as one could see in the case of the Pont des Arts.

[311] Félix Tourneux, op. cit., col. 418

[312] In 1833, the *Commission des Monuments Historiques* was established to restore the Gothic monuments.

and window frames. The cast iron flêche of the cathedral at Rouen (1828-36), built by Alavoine and exalted by some as a symbol of modernity, was the best example. (fig.74)

In 1843 Delaveleye, a Belgian engineer and a disciple of Durand, wrote an article in RGA, introducing a small cast iron pavilion in Gothic style, designed by Rigaud and elected in 1841 in the courtyard of the Palais de l'Industrie. He not only described it with a great enthusiasm, but also himself envisioned architecture which would be constructed entirely of cast iron.[313] The form of new cast iron architecture, he predicted, with Gothic style as a reference, should be something which would surpass even Gothic architecture in its lightness and the abundance of decoration. He wrote:

> La fonte est susceptible de recevoir les formes les plus variées par le moulage; sa solidité est énormément plus grande que celle des matériaux habituellement employés; on doit donc prévoir pour les constructions qui emploieront exclusivement le fer, une légèreté de formes, une abondance de décorations qui permettront d'outre-passer ce qui a été exécuté et même rêvé dans l'architecture gothique.[314]

It was after the mid-1840s that iron was finally highlighted as an agency for a new architecture without reference to historical styles. By this time, the technology of iron construction had advanced further and was more extensively used in architecture. As already discussed, Polonceau truss was invented in the late 1830s. During the 1840's, contractors and architects, such as Jacquemart, Baudrit, Leturc and Vaux, proposed several variations of the Ango beam, and invented new iron floor and roofing systems.(fig.75) These iron floor systems were commercialized and disseminated after the carpenters' strike in 1845.[315] The most important development of iron construction during the mid-

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313 A. Delaveleye, "Des constructions en métal," RGA (1843), col. 403

314 Ibid., col. 411

315 Especially systems by Bellemère, Jacquemart, Baudrit, Leturc between 1846 and 1846, and Vaux, Batleir, Joly in 1847. All these systems were published in the RGA. Of the many designs of new spanning systems dating from the period of the strike, that of the builder Vaux, which incorporated flat wrought iron bar joists, was most successful.

nineteenth century was, however, the use of the I beam, which was rolled in 1846 at La Villette by Flachat for the use of the Saint Lazare station built in the same year.(fig. 76)[316] The production of rolled iron of I and T section and the development of science of the statics made it possible for engineers and architects to span longer distances with the light structure of iron girders.

With the development of technology of iron construction and of modern commerce and industry, new building types of huge iron public halls, such as railway stations, market halls and public winter gardens, began to appear. The construction of the railway beginning in the late 30s required a structure to serve as passengers halls and train sheds covering the tracks so that passengers could board the car without exposure to bad weather. A railway station was a completely new type of architecture that had no historical precedent and thus, its disposition and construction were studied by architects and engineers from the early 1840's.[317] The railway stations should have a large interior space in order to disperse the smoke and steam of locomotives. Although new railway stations had been built in the early 1840s, they were still incipient. At first, the train shed was built with wood. However, a wood frame had the disadvantage of deteriorating through the effects of exposure to the steam. With the development of iron spanning technology in the 1840's, engineers, most of whom were Saint-Simonians, gradually used iron or a combination of wood and iron to span the train sheds.

Léonce Reynaud's Gare du Nord, completed in 1846, was the first major railway station in France, where cast iron columns were employed. In 1843, Léonce Reynaud for the first time proposed a single iron span of 110 feet for the Gare du Nord. But, for economic reasons, two wooden spans were erected with cast iron columns instead.(fig. 61, 62) When the Gare du Nord was completed in 1846, César Daly praised its iron columns

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[316] Zorès succeeded in commercially rolling I beams in 1848, and sold them directly to the public. At the National Exposition of Industry held in Paris in 1849, a large number of the new designs of iron floor using T or inverted T or I section were exhibited.
[317]Polonceau and V. Bois, "De la disposition et du service des gares et stations sur les chemin du fer," RGA, 1840, cols. 513-543; Daly," Des gares de chemin de fer," RGA (1846), col. 509 ff.

as suitable in light of their necessarily elongated proportions.[318] Between 1847 and 1852, three new railway stations were built in Paris, using iron more extensively. They were built with single larger spans of iron truss. The Gare de l'Est was begun in 1847 by Francois Duquesnoy. Victor Lenoir and engineer A. Baude built the Gare de Mont-parnasse spanning 48 meters (1848-52). A. Cendrier and engineer A. Julien built the Gare de Lyon divided into two 21. 5 meters spans by a row of cast iron columns.(fig.77) Reynaud advocated the use of iron in railway stations in the second volume of his Traité de l'architecture, published in 1858:

> It was the spontaneous consequence of one of the most admirable inventions of the époque opening up new horizons, new materials and new forms. . . Iron forms the rails and should have a part in the building they give rise to. It would be appropriate to glorify in some way the precious material to which industry has just given birth and which has endowed architecture with the most beneficial invention of the epoch.[319]

Another important type of public iron hall which emerged in the mid-1840's was the public winter garden. Around the time when the first iron railway stations was constructed, a couple of pubic winter gardens were constructed in large cities such as Paris and Lyon. The Jardin d'Hiver constructed by Rouhault in 1836 was a public winter garden. But the access to the winter garden was limited to high society. The first public winter garden in the real sense was one that was constructed by Hector Horeau in Lyon in 1847.(fig. 78) Another public winter garden was completed in the Champs Elysées between 1846 and 1848 by Meynadier and Rigolet. The Paris winter garden was over 130 feet wide and 60 feet high. It was carried on a continuous wrought iron arch, which was supported on rows of cast iron columns. It was opened as an amusement establishment; there were cafes, restaurants and art galleries, ballrooms, theaters. There was also an

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[318] Daly, "Gare du chemin de fer du Nord," RGA (1846) col. 530.
[319] Reynaud, Traité d'architecture, vol. 2 (1858) pp. 468-469.

assembly place for the public. On holidays, it was said 7000-8000 people gathered there.[320] (fig. 79)

The huge space covered by the light structure of iron truss realized in the winter gardens and railway stations became a model in establishing an architectural type of a market place as well. Arcades and bazaars had been developed as an architectural type during the 20s and 30s. With increasing commerce after 1840, a construction of a new market place was needed. In 1845, Hector Horeau proposed a design for a huge market hall. Although his first design used timber as a construction material, he gradually conceived of iron for the hall because of its fire resistance and re-usability, on which he repeatedly placed an emphasis.[321]

With the emergence of new building types of iron, iron appeared as a new material agency to create a new architecture. However, it is important to note that it was through the debates on style between Classicists and Gothicists which occurred during the mid-1840s, that the iron constructions entered architectural discourses as a determinant factor for a new style of architecture for the future. As I will discuss in the next chapter, it was in the midst of the debate on the style of modern religious architecture between Gothicists and Classicists, a group of rationalist architects and critics began to argue that it was in neither Gothic nor classic, but in the emerging iron architecture that one should find the answer for the architectural style for the future.

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[320] Ibid.

[321] Horeau's proposal for the central market was rejected. Instead, Baltard's design of stone hall was chosen and began to be constructed. However, since Baltard's design was unfit for the modern commerce, Flachat, a Saint-Simonian engineer, was requested to submit a project for the central market with iron structure.

Chapter Six: Emergence of Iron Construction as a New Architecture of Modern Society, 1846-1851.

> Nous sommes arrivés à une époque qui demande encore plus de marchés publics, d'usines, d'entrepôts, de gares et de stations de chemin de fer que d'arcs de triomphe et de temples éléves à la gloire... le programme d'une station de chemin de fer peut offrir quelque chose de la netteté indispensable à la production d'une œuvre d'art.
>
> César Daly, RGA, 1846

> Les grandes révolutions architectoniques ont toujours suivi les grandes révolutions sociales.
>
> Jobard, RGA, 1848

Debate on the Style of Modern Church between Gothicists and Classicists, 1846-

As discussed in chapter four, the Gothic movement of the 1830s originally intended the restoration of Gothic monuments. However, with the establishment of the romantic eclecticism which sought for a new architectural doctrine outside the Greco-Roman tradition, Gothic style began to be proposed as an alternative to classicism. Influential for the Gothic revival was the emergence of Montalembert's new Catholicism in the mid-1830s.[322] Comte de Montalembert's new Catholicism not only considered the Gothic cathedral as more appropriate than neoclassical churches for a modern religious building, but also propagated it as the Catholic style *par excellence*. The construction of Gothic churches in France, which began about 1840, was, thus, practiced as a Catholic religious discipline.[323]

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322 Comte de Montalembert's collection of articles was published in 1839 as Du vandalisme et du catholicism dans l'art.

323 The best account of French Gothic revival written in English is to my knowledge Robin Middleton and David Watkin's Neoclassical and 19th century Architecture II (New York: Rizolli, 1980.) This is an abridged version of Middleton's Ph.D. Dissertation, Chapter 4.

The production of Gothic cathedrals as an alternative to the neoclassical church for a modern religious building bothered the Academy and the classicists of the Conseil Générale des Bâtiments Civils. The Academy and the Conseil did not want Gothic churches to represent religious architecture of their time. This difference in visions for the style of modern churches triggered serious debates between Gothicists and Classicists, which culminated in 1846.

The debate started with the construction of the church of Ste.-Clotilde. In 1840, when Franz Christian Gau (1790-1853) proposed a Gothic church of Ste.-Clotilde at the place Bellechasse, in the west of Paris, by the request of Claude-Philibert-Barthelot Rambuteau, the *Prefét de la Seine*, the Conseil Général des Bâtiments Civils rejected the project. The Conseil's rejection of the Gothic church was based on technical, economic reasons as well as an aesthetic one. Many members of the Conseil claimed that the church resembled too much the cathedral of Cologne, preferring thirteenth century Gothic style. But, their real motivation for the refusal of accepting the design was, most probably, their reluctance to allow a conspicuous example of Gothic revivalism.[324] They also rejected Gau's design, arguing that massive iron reinforcements such as iron cramps and tie rods would be required for the construction. Gau referred to the experience of other Gothic restorers to convince the commission that the use of iron as a means of consolidation in Gothic restoration was not only unnecessary but also harmful to the construction.[325] Although iron was used in Gothic construction in rare cases, Daly himself shared Gau's opinion, writing "ces monument appartiennent à l'époque du déclin de l'art ogival, et comme si mensonge devait rencontrer en lui-même punition, le fer, destiné à consolider ces édifices, n'a servi que trop souvent à hâter leur destruction, par suite de sa sensibilité aux influences atmosphériques."[326]

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324 Daly, RGA, 1846, cols. 315-6

325 Extracts from the letters which were sent to Gau by the architects of Gothic restoration were reproduced in "De l'emploi du fer comme moyen de consolidation dans les monuments gothiques," RGA (1841), col. 23 ff.

326 Ibid., col. 23

However, it should be reminded that the nineteenth century was a period when Gothic constructive principles were no longer applied to building construction; the development of modern science and construction technology had already rendered Gothic structural principles useless.[327] Therefore, it was natural that, for economic and technical reasons, the commission required the construction of the new Gothic cathedral to depend on the modern techniques of iron reinforcement and the cast iron elements which would replace those of wood and stone.

However, the use of the modern technology of iron reinforcement for Gothic form was unacceptable to Gothic revivalists. They believed that the construction of a Gothic church should be based on the exact restoration of Gothic construction principles, rather than on modern materials and technology. The use of iron for a Gothic form was criticized largely for moral and aesthetic reasons. In the 1841 Revue générale de l'architecture, Felix Tourneux criticized the simple substitution of stone elements with iron in Gothic restoration. Taking the example of the cast iron bell tower of the cathedral at Rouen, he scorned it as "*mesquine*" and a "*mensonge ridicule.*" He argued that although it might be economic to use iron in Gothic restoration, if one wants to preserve the purity of Gothic form, the economic issue should be subsidiary:

> . . . nous croyons néanmoins qu'il nous est permis de signaler quelques-uns des écueils que l'on ne manquerait pas de rencontrer, si l'on voulait s'obstiner à chercher quelque chose de nouveau dans une simple substitution de matériaux avec la conservation de formes anciennes.
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> . . . . L'essai qui a été fait pour la reconstruction du clocher de la cathédrale de Rouen n'a pas été heureux, et certes il n'est personne qui ignore combien est mesquine et ridicule cette flèche qui ne semble être qu'un véritable squelette d'elle-même. Autant il y a de grâce et de légèreté dans ces admirables découpures de pierres que les architectes du XIIe au XVe siècle ont répandues sur la surface du monde chrétien et féodal, autant il y a

[327] In this regard, it seems important to note that the Gothic revival of the nineteenth century was basically different from Greco-Gothic rationalism of Soufflot et al in the eighteenth century before the development of modern material and construction technology which was analysed by Middleton .

de mauvais goût et de raideur dans ces espèces de grillages, dont les lignes se croisent et s'embrouillent sans profondeur et sans perspective.

> Par la substitution de la fonte à la pierre, ce qui était gracieux et élancé devient maigre et décharné, toutes les fois qu'on cherche à allier avec une économie de dépense la forme créee pour matériaux déterminés.
>
> Que si, au contraire, on veut conserver aux formes gothiques toute leur pureté et leur plénitude, le motif d'économie disparaît. La construction première devient dispendieuse et nécessite des dépenses d'entretien considérables pour la conservation artificielle d'une apparence grossièrement trompeuse.[328]

In his study, Tourneux even suggested that substitution of stone by iron elements in Gothic restoration is in some cases more expensive.

> Dans un moment où les louable efforts du Comité Historique des Arts et des Monuments tendent à sauver les monuments précieux de notre architecture nationale qui ont pu échapper à toutes les vicissitudes de nos révolutions et à la longue incurie de certains administrateurs, . . . le projet de l'église Saint-Germain. L'auteur avait précisément proposé, comme une innovation à la fois heureuse et économique, l'emploi de la fonte dans toutes les parties légères de l'édifice et en particulier pour les fenêtres. On peut juger. . .s'il avait atteint son but. L'idée d'une semblable substitution, séduisante peut-être au premiér coup d'œil pour ceux qui oublient l'alliance intime qui existe dans les arts entre la forme et la matière, ne supporte pas même l'épreuve des chiffres, et la raison d'économie se joint ici à celle de l'harmonie pour repousser un mensonge ridicule et ennemi du progrès.[329]

By the request of the Conseil Général des Bâtiments Civils, Gau revised his design of the church of Ste.-Clotilde at least three times. Yet the construction of the Gothic church was not approved until 1846. In 1844 the north tower of the church of St. Denis, which was under restoration by a member of the Conseil, François Debret, was found to be in a

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328 Ibid.
329 Ibid., p. 420

state of collapse of its own weight. The following year, the Conseil Génénral des Bâtiments Civils arbitrarily refused to permit the construction of three churches in Gothic style: St.-André at Rheims, St.-Aubin at Toulouse and St.-Étienne at Tours. These two incidents infuriated Gothic revivalists and made them respond with vigor to the Conseil des Bâtiments Civils, most of whose members were in fact Academicians.[330] The Gothicists attacked the Greek revivalism of the Academy, on one hand, and presented theories for the Gothic revival through the Annales archéologiques, which Didron began to publish in 1844.

The most active propagandists for the revival of Gothic architecture were Adolphe-Napoleon Didron (1806-1867), Jean-Baptiste-Antoine Lassus and Eugène-Emmanuel Viollet-le-Duc. In his introduction to the 1844 Annales archéologiques, Didron declared the death of Greco-Roman style in the Panthéon, the Madeleine and the church of St. Vincent de Paul in Paris. Claiming that there was no future in the architecture of Greece and Rome, he argued that the Gothic revival was inevitable:

> le règne des styles grec et romain est définitivement aboli avec le Panthéon de Paris, le pseudo-grec, qui a eu la vie dure et longue, agonisait; il vient de mourir dans la Madeleine. Quant au style pseudo-romain, il est en train de se suicider à Saint-Vincent-de-Paul. C'est à l'art chrétien qu'on demande aujourd'hui des inspirations pour les monuments chrétiens.[331]

Lassus and Viollet-le-Duc, on the other hand, based their advocacy of Gothic architecture on its rational principles, rather than on its romantic aesthetics. Lassus was a disciple of Henri Labrouste. Like many other disciples of Labrouste and romantic rationalists of the 1830s, he studied Renaissance architecture and then turned to the thirteenth century Gothic architecture, applying Labrouste's rationalism to the interpretation of Gothic architecture. Through his study, Lassus developed a critical view of the

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330 See Robin Middleton, op.cit.

331 Didron, Annales archéologiques (1844), p. 2-3

rationality of Greek architecture, and advocated instead the rationality of Gothic proportion. First of all, Lassus criticized that Greeks had no regard for human proportion: "l'Art antique n'a pas égard à la dimension réelle; que le monument y soit grand ou petit, c'est toujours la proportion relative qui détermine les rapports des différentes parties. De sorte que le petit monument n'est qu'une réduction du grand, qui lui-même peut être considéré comme une exagération du petit."[332] Whereas in Gothic architecture, Lassus said for the first time," l'homme seul sert toujours d'unité."[333] In Gothic architecture, thus, the size of the architectural elements, columns, capitals and moldings, was fixed; they varied only in accordance with structural requirements and the quality of materials used. Thus, while Greek decoration was unchanging and monotonous, "le principe de la décoration gothique est toujours la vérité dans l'unité . . . avec la liberté la plus franche."[334]

Although Lassus did not believe in the revival of the Gothic as it was, he felt that the only hope for the future in the chaotic state of contemporary architecture lay in the past. Lassus then recommended the Gothic since he believed Gothic construction was not only more economical and efficient than any other past styles, but also French and uniform in its inspiration.[335] In this respect, Lassus differed from other Romantic rationalists who searched for a new style of architecture through eclectic studies of history. He wrote:

> Les rationalistes proclament *l'éclecticisme*; nous, nous défendons *l'unité* dans l'art. Ils pensent qu'on peut emprunter des formes à tous les arts, à tous les pays, à toutes les époques, en inventer même, et les réunir en les amalgamant, de manière à produire un tout complet, homogène, et à créer, de cette façon, un art nouveau. Nous, au contraire, nous trouvons que la chose est impossible, impraticable, et que la tentative est folle. Voilà, nous le pensons, la position nettement dessinée. Convaincus, comme nous, de la nécessité d'une réforme prompte et radicale, ils croient que l'art doit aujourd'hui procéder de tous les arts antérieurs, quels qu'ils soient, tandis

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[332] Lassus, "De l'Art et de l'archéologie," Annales archéologiques, (1845), p. 201
[333] Ibid., p.202
[334] Ibid., p.203
[335] See Lassus, "De l'Art et de l'archéologie," Annales archéologiques (1845), pp. 329-335

que nous pensons, nous, qu'il doit procéder entièrement d'un seul, de notre art national. Telle est la différence de nos opinions.

. . . par suite de la nécessitié de répondre à des besoins nouveaux, vous arriverez, nécessairement et peu à peu, à une transformation du gothique, à une nouvelle expression de cet art qui est le nôtre.[336]

Viollet-le-Duc, the other principal advocate of the Gothic revival, outlined his rational theory of the Gothic in his "De la construction des édifices religieux en France depuis le commencement du christianisme jusqu'au XVIe siècle," published in the Annales archéologiques between 1844 and 1847, which he later developed further in the Dictionnaire raisonné de l'architecture Française. Viollet-le-Duc's concern was to explain the Gothic in the simplest rational terms. The whole discussion was on the structure, the material, and practical characteristics of Gothic architecture. For him, the history of Gothic architecture was nothing more than the development of an efficient and economic structural system, a solution to the problem of structure. The whole system was a system in equilibrium, "une mode de construction élastique." He also argued that architecture is the clear expression of its function: "Nous croyons que l'art de l'architecture a pour but l'expression d'un besoin, et il faut alors que l'ensemble comme les détails de cet art, que la composition et l'exécution concourent à ce but."[337] Gothic architecture was a successful expression of the needs of thirteenth century Frenchmen, as was Greek architecture for the Greeks.

Thus, Viollet-le-Duc, like Lassus, was led not to endorse the simple imitation of a Gothic form. He wrote: "Nous croyons donc devoir dire ici que nous repoussons comme aussi mauvaise, et plus mauvaise encore que l'imitation fausse de l'architecture antique, l'imitation fausse de l'architecture gothique."[338] Yet, his arguments made a clear case for a Gothic revival: "not an unthinking imitation of Gothic forms but as with Lassus- a carefully

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[336] Ibid., p. 333
[337] Viollet-le-Duc, Annales archéologiques (1846), p.267
[338] Viollet-le-Duc, Annales archéologiques (1845), p.333

reasoned re-application of Gothic structural elements."[339] It was in part for this reason, along with practical problems of joining different materials, that the rationalist advocates of the Gothic revival, Lassus and Viollet-le-Duc, also opposed the replication of Gothic form with modern materials and techniques. They rejected the use of iron in Gothic restoration and criticized the replacement of Gothic stone elements with iron. In the 1843 report on restoration of the church of Notre Dame, Viollet-le-Duc and Lassus condemned Alavoine's use of iron at the Rouen cathedral.

> La fonte, qui se moule d'une seule pièce, ne peut donner des moulures de la pierre refouillées au ciseau. Les mastics et ciments auront toujours la sécheresse de la pâte modelée, jamais le grain de la pierre. C'est donc en pierre qu'il faut restaurer les édifices de pierre, non plus par de simples incrustements de surface plus ou moins mal liaisonnés, mais par le remplacement intégral des parties attachées: piliers, voûtes, arcs-boutants, contreforts. L'édifice doit reprendre sa santé, sa solidité, retrouver ses éléments constructifs antérieurs, son identité de formes.[340]

Even though they themselves sometimes used iron window frames and iron reinforcements in the restoration of Gothic churches, such as those at Saint Germain l'Auxerrois and at Vézelay, Lassus and Viollet-le-Duc firmly rejected the use of iron on the exterior of the buildings especially because they believed it would create the practical problem of jointing the different materials.

What the rational Gothic revivalists such as Lassus and Viollet-le-Duc believed to be modern in Gothic architecture then was the universality of Gothic structural principles. With this Gothic rationalism, they could move towards the creation of nineteenth century architecture without imitating the Gothic forms with modern techniques. In other words, "the nineteenth century architecture was to be the visible expression, in contemporary

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339 Robin Middleton, Viollet-le-Duc and the Rational Gothic Tradition (Ph.D. Dissertation, Cambridge Univ., 1958)

340 Lassus et Viollet-le-Duc, Notre Dame de Paris, projet de restauration, rapport (Paris, 1843) p.5

terms, of a system evolved in the thirteenth century."[341] It was in this context that Viollet-le-Duc was able to argue that restoration of the Gothic structure was essentially an occupation of the nineteenth century.[342] The close relationship between the restoration and the construction of the building of the nineteenth century was developed later in his theory of restoration in his Dictionnaire which was published starting in 1858. In fact, Viollet-le-Duc and Lassus' contribution to the Gothic revival was mostly through their restoration projects. Through the restoration of the church of Ste. Chapelle (1838) and of Notre Dame in Paris (1843-), they trained many architects in Gothic principles, which the architects used later in the construction of Gothic churches.

In 1846, after the protests and threats from the Gothicists, the construction of the Ste.-Clotilde was finally passed in the Conseil des Bâtiments Civils by the margin of one vote. However, A.-N. Caristie, a member of the Conseil, submitted a questionnaire to the Academy, questioning the validity of using Gothic style for nineteenth century churches. The Academy's discussion on these questions was summarized in a Mémoire by Raoul Rochette, *Secretaire perpetuel* of the Academy, and published in 1846.[343] Although the members of the Academy might admire the romantic charm of Gothic buildings and although they might approve of the restoration of Gothic cathedrals, they were unable to sanction the construction of Gothic churches in nineteenth century France. However, they equally opposed the imitation of classical architecture. Instead, the Academy suggested to select elements from the past styles in an attempt to create a new nineteenth century style, thus justifying eclecticism. Raoul Rochette wrote,"...de créer des oeuvres qui leur soient propres en recueillant dans le passé, en choisissant dans le présent tout ce qui peut servir à leur usage."[344] This, he declared, was the duty of present day architects.

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341 See Robin Middleton, Viollet-le-Duc and the Rational Gothic Tradition (Ph.D. Dissertation, Cambridge Univ. ,1958)

342 See ibid., Chap. 4

343 Raoul Rochette, "Du style gothique au XIXe siècle," AA (1846), p. 325ff. The Mémoire was also reprined in RGA, 1846, cols. 316 ff.

344 Raoul Rochette, "Du style gothique au XIXe siècle," Annales archéologiques (1846), p. 332

Viollet-le-Duc immediately responded, criticizing Raoul Rochette's eclecticism: "Lorsque l'Académie des Beaux-Arts installait franchement l'antiquité chez nous, . . il y avait au moins unité, harmonie dans l'enseignement, dans les exemples et dans les résultats. C'était un art dont la forme était en désaccord avec nos mœeurs et notre climat; mais c'était un art admirarble, . . . Aujourd'hui vous prêchez l'anarchie, l'éclectisme."[345] He did not believe that the eclecticism could create a new style, and considered it as a poor tactic to save the Academy against the Gothicists. "L'Académie croit qu'avec cela nous aurons une architecture de notre époque: nous aurons ce que ce que nous aurons depuis vingt ans, du désordre."[346] And he wrote: "Pour former un art nouveau, il faut une civilisation nouvelle, et nous ne sommes pas dans ce cas."[347] Viollet-le-Duc thus accepted that the copy of a past style was inevitable in the contemporary situation. It was, then, through careful, structural studies of the rational and national style of the past, which is the Gothic, that nineteenth century France could create a new style. Viollet-le Duc accused Raoul Rochette and all the members of the Academy of refusing to recognize that the art of Gothic architecture lay in the dynamic expression of structure - a structure of superb refinement and economy-and that it had French roots.[348] Lassus, like Viollet-le-Duc, also concluded in his response that "pour nous, l'art gothique est une langue toute faite, et la seule qu'un artiste français doive employer pour exprimer ses idées, sauf à lui d'inventer des mots nouveaux."[349]

In short, while the neoclassicists of the Conseil and the Academy argued that a Gothic church was a past style and thus not suitable to the needs of the nineteenth century, the Gothic revivalists responded that the Gothic was not simply a style of the past, but a national style based on rationality and economy, which could be used in modern society as

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345 Viollet-le-Duc, "Réponse aux considérations de l'Académie des Beaux-Arts, sur la question de savoir s'il est convenable, au xixe siècle, de bâtir des églises en style gothique," Ibid., p. 337

346 Ibid., p. 337

347 Ibid., p. 351

348 Viollet-le -Duc, "Du Style Gothique au XIXe siècle," Annales archéologiques (1846)

349 J.-B. Lassus, "Réaction de l'Académie des Beaux-Arts contre l'art gothique," Moniteur des arts, 24, 25, (1846).

well. On the other hand, when the Gothicists criticized neoclassical churches on the grounds that it was unsuitable for their habit, for the Christian religion and for the modern way of life, neoclassicists of the Academy retorted that they were not imitating the Greek temple, but merely sought inspiration from the eternal principles of beauty it embodied. They claimed that they were trying to create a new style with conventional forms by using the rational application of various elements of the past styles.

After all, through the debates, the Gothicists reached the same conclusion as the Classicists. The Gothicists and Classicists alike were trying to find a style of modern architecture by means of historically given models; while the former believed the Gothic to be a model because of its rationality and national roots, the latter considered Classic an ultimate reference. Thus, the real question in the debate between the Academicians and Gothicists was not one style over another. It was a demand for a new style, a program for future architecture. In this, however, Viollet-le-Duc and the Gothicists were as unsound as Raoul Rochette and the Classicists.

Emergence of Iron Construction as a New Style of Modern Architecture, 1846-48

It was in the midst of the debates on style between the Gothicists and the Classicists that a few liberal architects began to voice their opinion that a modern religious building should be created without reference to historical styles, either Classic or Gothic. In 1847, the architect Auguste Magne wrote a letter to the RGA, arguing that modern religious architecture should be inspired neither by Gothic nor by Greek building, but by the "sujet lui même, conçu dans des conditions d'harmonie avec notre climat, nos mœurs et notre civilisation.[350] However, he sided with the Academy, arguing that this position corresponded to a liberal philosophy within the Academy. In his response to Magne's letter, Cesar Daly, agreed that modern architecture should be created based on the principles of liberty and progress in art rather than by conforming to the historically given forms. He

[350] Auguste Magne wrote to the editor of the RGA in 1847, col. 205, cf. also 402, 431 (by Daly)

wrote, "nous n'avons que des louanges pour cette tendance vers la liberté; de même cependant que nous protestons contre ceux qui voudraient faire de l'architecture moderne tout simplememnt l'art de construire conformément aux données de l'histoire, . . La tradition, le passé, et la basè sur laquelle il faut fonder tout progrès; car ce passé, c'est l'expérience humaine tout entière, c'est l'enseignement des siècles."[351] However, Daly disagreed with Magne's uncritical endorsement of the Academy and the Ecole's eclectic principles. In order to arrive at the goal of creating a new modern style, Daly argued, more fundamental questions should be resolved. Daly pointed out that although the Academy protested against the modern churches of Gothic style during the debates, no author had raised such fundamental questions as: "Qu'est-ce qui constitue un style d'architecture?" and "Quelles sont les conditions sous l'influence desquelles un style d'architecture se transforme? [352] By arguing that an architectural style respond to a certain system of construction and to "une forme sociale déterminée, à un sentiment religieux, plus ou poins éclairé, à un climat donné, à une industrie plus ou moins avancée, à de certains matériaux , etc., etc.,"[353] Daly thus reclaimed the basics of the rationalists of the 1830s and 40s.

Although Daly acknowledged the importance of "liberté en matière d'art" in the creation of modern architecture, this alone was not enough because, as Daly criticized, "l'institut, au nom de la liberté, condamnait les églises modernes de style gothique. Au nom de la liberté encore, les adversaires de l'institut condamnaient l'art antique." Thus, Daly went on to argue:" Au nom de la liberté aussi, nous sommes venu à notre tour, et nous avons dit: Qu'on laisse chaque artiste libre de consulter et interpréter sa propre nature et forces, et le sentiment public, et qu'à l'exemple du grand Molière, sans se faire un copiste servile, il prenne son bien partout où il le trouvera."[354]

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351 Daly, "De l'architecture religieuse au XIXe siècle," RGA (1847), col. 206f
352 Ibid., col. 208
353 Ibid.
354 Ibid.

In fact, during the debates between Neoclassicists and Gothicists, Daly took a neutral position. Daly wrote in the editorial of the RGA, three years later, of "...the almost neutral position that we have generally kept between the defenders of the academic classic doctrines of the Institute and neo-Gothicists."[355] However, Daly recognized the importance of the debate; he noticed that the debate of the style of the modern church was in fact a matter of all modern architecture, and did not only concern the modern church. Introducing the Academy's Mémoire in the 1846 RGA, Daly already noted the significance of the debates on modern architecture, and expressed his great interest in it. He wrote, ". . . le sujet dont il traite est, en effet, un des mieux faits pour exciter l'intérêt des artistes. Il embrasse toutes les questions importantes de l'architecture moderne, et veut être exposé avec ampleur et gravité."[356] He was more specific in the 1847 article: "Si la question du style moderne de l'architecture religieuse était résolue, celle du style de toute l'architecture moderne serait bien près de l'être aussi; car, de même que la religion d'un pays colore profondément toutes les institutions sociales de ce pays, de même le style de l'art religieux jette un puissant reflet sur le style de l'art tout entier." [357]

César Daly then began to see the emerging iron architecture as new architecture for the future. Writing about a modern style which would be neither gothic nor classic in the 1847 article, Daly, thus, mentioned the railway station, " . . . de même aussi nous crierons gare! à ceux qui prétendraient créer de toutes pièces un art nouveau *sans aucun lien* avec les formes de l'art historique." [358]

Already a year earlier in 1846, when Reynaud's Gare du Nord was completed and the debates between the Gothicists and Classicists were all but over, Daly wrote a seminal article on railway stations, where he argued that architects should create a new style of

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[355] Daly, "Introduction," RGA (1849), col. 6. " . . . position presque neutre que nous avons parfois fardée entre les défenseurs des doctrines classiques de l'*Institut* et les *néo-Gothiques."*
[356] Cesar Daly, "Opinion de l'Académie Royale des Beaux-Arts sur l'Architecture Gothique," RGA, 1846, col. 316
[357] Daly, "De l'architecture religieuse au XIXe siècle," RGA (1847), cols. 207-208
[358] Ibid. col. 206. In the same issue of the RGA in 1847, Daly wrote an article" De la liberté dans l'art "(1847), where, criticizing both classicism and the neo-Gothic, he argued once again that it was neither classic nor gothic but the style of iron architecture that future architecture must rely on.

architecture in modern society, which would characterize modern commerce and industry, neither imitation of Gothic nor of Classic. And this architecture, he predicted, was the new railway station and other commercial and industrial architecture of iron construction. I believe it is worthwhile quoting this rather long passages of Daly's article.

> Le génie de l'artiste est avant tout un génie créateur, et les architectes se révoltent avec raison contre ceux qui voudraient les confiner dans tel ou tel siècle, et borner leur activité à recombiner les formes connues de tel ou tel style ancien. C'est au nom de la dignité de l'artiste, des droits de l'intelligence, de la liberté du génie créateur, qu'on a frappé et brisé la table des vieilles lois classiques, et qu'on repousse encore les tentativess des néo-gothiques. . . . .
>
> . . . .nôtre société a un caractère qui la distingue nettement des époques antérieures, que ce caractère doit trouver son expression dans l'art contemporain, et que c'est aux artistes modernes, usant du droit de libre création, de chercher avec sagesse et prudence, à l'exemple de leurs prédécesseurs du moyen âge et de l'antiquité, les formes de la nouvelle langue architectonique convenant aux temps nouveaux.
>
> . . . Notre régime actuel de liberté religieuse, politique et civile, l'immense développement du commerce, le développement encore plus immense de l'industrie, qui chaque jour fournit des produits nouveaux, les progrès des sciences et des arts d'application, l'emploi de la vapour sur terre et sur mer, la télégraphie électrique, l'usage habituel de la fonte et du fer dans les constructions, etc., constituent, certes des différences bien assez marquées pour laisser comprendre que les besoins intellectuels, moraux et matériels de la société de XIXe siècle, que les matériaux et les puissances qu'elle offre à l'architecte, ne sont pas tout à fait ceux du XIIIe ou meme ceux du XVIe siècle. . . .
>
> L'industrie et le commerce sont les *caractéristiques* de notre temps; ce sont . . . les plus puissants moyens de faire fortune, et, par suite, d'exercer une action dans le monde, d'acquérir de l'influence, des honneurs et de la considération dans la société.
>
> L'architecture, dans ses rapport avec le commerce et l'industrie, mérite la profonde attention des artistes sérieux. Nous sommes arrivés à une époque qui demande encore plus de marchés publics, d'usines,

> d'entrepôts, de gares et de stations de chemin de fer, . . . C'est dans ces constructions nouvelles qu'on a commencé à donner un grand développement à l'architecture en fonte et en fer. . . le nécessité de satisfaire à des besoins nouveaux y a fréquemment conduit à l'adoption de lignes, de formes et de proportions qui ne se rencontraient pas dans l'alphabet architectectonique.[359]

Daly then concluded the article, declaring that:

> Un jour viendra sans doute où les gares de chemins de fer compteront parmi les édifices les plus importants, où l'architecture sera appelée à déployer toutes ses ressources, où leur construction devra être monumentale. Les gares pourront être mises alors sur la même ligne que les vastes et splendides monuments consacrés aux bains publics chez les Romains. [360]

By this time, the Ecole des Beaux-Arts had also changed. The campaign for the reform of the École clearly took effect and progressive tendencies began to be detected in the École. In 1845, Simon Constant-Defeux, one of the Romantic *pensionnaires* of the 30s became Professor of perspective and in 1846, Abel Blouet, a rationalist of the 1830s, was appointed Professor of theory after the death of Baltard. The professors of the École now welcomed the new materials and accepted that the architects must adopt what was available to them and develop new forms which were best suited to the new materials and to modern social activities. A studio project given by Constant-Defeux in 1846, for example, was a church of cast iron.[361] In 1847, Blouet published the Supplément de la Traité théorique et pratique de l'art de bâtir de Jean Rondelet (1847-48) as a text book for students, which was intended as an extended edition of Rondelet's' book, published in 1802. The power of

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359 Daly, "Des gares de chemin de fer," RGA 6 (1845-6), cols. 509- 511
360 Ibid., p. 517
361 Hautecœur, op. cit., vol. 7. p. 307 Quoted in Steiner, op. cit., p. 11.

iron as a new agency for future architecture was also strongly felt in Blouet's book. In the section *serrurerie*, Abel Blouet wrote, expecting the new form of iron architecture:

> Par les progrès qu'a déjà faits l'emploi du fer comme élément de construction, il nous paraît certain que, vu la grande variété de combinations auxquelles peut se prêter cette matière, elle est appelée à opérer une révolution dans l'art de bâtir, révolution qu'il faut admettre, qui est déjà commencée, et qu'il appartient aux architectes de bien diriger pour qu'elle ne dégénère pas en abus par le faux emploi qu'on pourrait en faire.[362]

In his book, Blouet criticized imitation of historical styles and neoclassical decoration with iron as improper. He argued that its form should be determined by its natural property, anticipating a new style of iron architecture.

> . . . on a fait, . . . un mauvais emploi de la matière en imitant le fer, et sans nécessité, des formes qui ont trouvé leur origine dans l'emploi de la pierre ou d'autres matériaux qui ne peuvent avoir de solidité que sous un gros volume...
>
> La vérité. . . , on admettra avec nous que chaque matière doit affecter des formes qui lui soient propres et qui soient en quelque sorte déterminées par sa nature . . . le fer étant, une matière qui, sous un petit volume, donne comparativement beaucoup de force, c'est à faire des choses légères qu'il doit être employé, par exemple, à couvrir de grandes espaces lorsque l'on veut réduire le plus possible les points d'appui.[363]

During the latter part of the 1840s, especially during Blouet's tenure, the program for the monthly *concours* of the École included more industrial, commercial and mass cultural buildings than ever before. Iron was frequently used in student designs for those

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[362]Abel Blouet, Supplément de la Traité théorique et pratique de l'art de bâtir de Jean Rondelet (1847-48) p. 21-22.
[363] Ibid.

projects (jardin d'hiver, 1835; marché, 1846; bourse, 1849, by Davioud; maison en fer, 1852, by L.-C. Bruyère, etc.)

Faced with the enthusiastic calls in favor of a new style of iron construction, however, some architects still found the stylistic reference in the Gothic or Renaissance. In 1847, Romand designed an iron hospital and published it in 1847 RGA (fig. 57) In the article, Romand advocated new forms of iron architecture:

> Les règles suivies jusqu'à ce jour pour l'établissement de construction dans lesquelles le fer n'avait qu'une médiocre importance, doivent être nécessairement modifiées par l'emploi d'une matière qui, sous un volume de quelques centimètres, résume la solidité de plusieurs décimètres de bois ou de pierre, et l'on n'imitera pas toujours certains constructeurs qui, sous l'influence de la routine, conservent aux colonnes en fonte les dimensions de celles en pierre.
>
> Pour employer convenablement la fonte, on est forcé de lui donner des nervures qui lui procurent une solidité plus grande que celle qu'elle aurait à poids égal mais sans nervures: des ornements sont également nécessaires pour masquer les joints.[364]

However, Romand was realistic about the style of iron architecture. He wrote," le caractère décoratif des constructions métalliques se rapproche davantage du style gothique fleuri et de la Renaissance, que de tout autre."[365]

In the emerging iron constructions, architects and engineers not only anticipated a completely new style of modern architecture without references to historical styles, but also envisioned a social utopia. The huge public halls with exposed iron structure were conceived as a materialization of the social utopia of the mid-1840s, an image of a new democratic mass society. For example, as pointed out by many historians, Horeau's

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[364] A. Romand, "Sur un hôpital en fer: construit au Camp Jacob," RGA vol. 7 (1847-8), P. 153,
[365] Ibid., col. 152 p.

project for the market hall was of so large a scale that contemporary technology could not achieve it. This lack of technological reflection in the projects testified to his utopian idealism and the romanticization of technology. He applied iron as a plastic problem, not as a technological problem. The technology of iron construction that Horeau employed was rather traditional. Horeau's utopian vision of a huge public hall was thus an image, and there was still an aspect of romanticism which the utopians of the 1830s had. This utopian image of public iron halls was related with the new associationism of people in the 1840s. Worker's association was a common ideology of social utopians in the 30s and 40s.[366] With the growing ideology of associationism of workers, the huge interior space with the exposed iron roof structure built by Saint-Simonian engineers served as an iconographical reference for the utopian idea of a mass democratic society.

The public winter gardens in particular served as the image of the social utopia of anti-individualism, an association of people. They were a triumph of the private entertainment industry. However, the association of people under the illusion of nature in the public winter garden represented the utopian idea of bringing the city workers who were alienated from nature in the age of industrialism closer to nature. It was not by chance that the public winter garden came into being at the time of sharpening conflict between class interests. In 1847, Daly, in his review of Horeau's Jardin d'Hiver, echoed the utopian ideas about the public winter garden:

> . . .voici un programme nouveau, un programme du XIXe siècle: un jardin sous verre! . . . les poètes, les utopistes, les rêveurs des siècle sont dépassés par les réalités de cette année 1847. Aussi, les moyens employés sont-ils essentiellement les moyens de notre temps; c'est l'industrie moderne qui les a fournis: c'est le fer, la fonte et le verre.[367]

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[366] See Moss, H. Bernard, The Origins of the French Labor Movement 1830-1914: the Socialism of Skilled Worker (Berkeley, Los Angeles: Univ. of California Press, 1976)

[367] Daly, "Jardins d'Hiver de Paris et de Lyon," RGA (1847), p.410

In this public winter garden, Daly himself envisioned the utopia of a garden factory. He continued: "Au moyen âge les fenêtres de la plupart des maisons de nos cultivateurs étaient sans vitres; aujourd'hui Paris et Lyon ont leurs palais en verre, leur jardins d'hiver. *Un jour peut-être les populations étoilées de nos ateliers et de nos fabriques auront aussi leur jardin d'hiver.*"[368]

Utopia of Modern Iron Architecture and its Demise, 1848-1851

The hope for a new architecture of iron both as a new style and as a social utopia reached its apogee after the 1848 February Revolution. First of all, under the idealistic and liberal atmosphere of the new Republic, huge iron public halls immediately emerged as a central theme of utopian socialist projects for Republican society. As Gottfried Semper reported, "in 1848, after the banishment of the House of Orlèans, there was a scheme to alter the whole wide area of the National Palace into a single grandiose winter garden with transportable roofing so that the plants could be in the open air in the summer and be covered in winter."[369] Hector Horeau, an utopian socialist architect, also proposed an iron hall for the Paris Exposition with a huge interior space. (fig. 80) The universal Exposition was destined to encourage industry and Beaux-Arts and thus, to serve as an instrument of progress of the Republic.[370] Under the Republic, Horeau anticipated "un gage du progrés économique, donc sociel et par voie de conséquence, moral."[371] He argued that the Exposition would represent "un énorme progrès civilisateur, jusque-la considéré comme un rêve, une utopie."[372] For Horeau, Palais L'Exposition was thus a temple for art and industry, and a cathedral of new religion based on commerce and

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368 Ibid. My italic.

369 G. Semper, "Der Wintergarten zu Paris," Zeitschrift für praktische Baukunst. vol. 9 (1849): 516-526. Translated and cited in George Kohlmaier and Barna von Sartoty, Houses of Glass (Cambrige, Mass: MIT Press, 1986) p. 31.

370 See Horeau, Mémoire sur l'embellissement des Champs-Elysées et les avantages que le gouvernement et la population Parisienne doivent en retirer, 1836.

371 Françoise Boudon, "Horeau et les Expositions Unverselles," Hector Horeau 1801-1872 (Paris,1978) p. 165

372 Ibid.

industry which must "répandre partout la civilisation, le vrai Christianisme."[373] In his proposal for the Exposition hall, Horeau also suggested to use the exposition building for housing the great gathering of the Republic.[374] Furthermore, betraying his socialist belief in workers' association, Horeau recommended that the National Workshops, which was formed by the Provisional Government after the Revolution, be responsible for its construction.[375] In his social utopia, artists, architects and artisan worked together,[376] and as the associationist movement developed, it was expected to bring about the union of all peoples on the globe.[377]

Under the liberal atmosphere of the Republic, architects and critics also expected the emergence of a new style of iron architecture. In 1849, in his introduction to Jobard's article, "Architecture métallique" which was originally published in 1848 and reproduced in Révue générale de l'architecture the following year, César Daly envisioned that iron architecture which would not be a copy of past styles was what the public anticipated.[378] He wrote: "Une architecture nouvelle, un style nouveau, qui nous sorte de la stérilité et du servilisme de la copie: c'est ce que chacun demande, c'est ce que le public attend."[379]

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373 Ibid.

374 "Galeries d'exposition des produits de l'industrie," RGA (1849), col 94 f: "Au projet de M.Horeau, adressé le mars 1848 à M. le ministre des tavaux publics, était annexé une demande de prochaine exécution de l'édifice, afin de l'utiliser pour les grandes réunions de la République."

375 Françoise Boudon, op. cit.

376 In fact, the relationship between architects and the organization of workers was ambiguous. Unlike artists who were progressive both artistically and politically, architects have never been avant gardes in political terms. It was only after the Revolution that architects supported working class causes. Ironically, when carpenters striked in 1845, architects urged in the RGA to use iron, which could be used without carpenters' labor. In 1845, Theodore Laches accused carpenters of partial association of violence and of exploitation of unaffiliated workers. Daly refused to take his stand to the great problem of organization of labor. During the strikes, architects distanced themselves from the workers. Their progresiveness towards technology transcended the class interest. Thus, architects' position on the technological progresivesness did not match the political position. Benjamin's thesis was thus confirmed already in the mid-nineteenth century.

377 B. H. Morss, op. cit.

378 Daly's activities during the Revolution were documented in Hélène Lipstadt, "Cesar Daly, Revolutionary architect?" The Ecole des Beaux-Arts (Architectural Design, 1978)

379 Daly, "L'Architecture de l'avenir," RGA (1849), col. 26. In the mid-nineteenth century, iron was appreciated as a potentially crucial material for a future architectural system by German theorists, such as Bötticher, as well. He argued that the emergence of modern architecture would be based on iron construction as opposed to stone architecture of the previous age. See, Carl Gottlieb Wilhwlm Bötticher, "Das Prinzip des Hellenischen un Germanischen Bauweise hinsichtlich des Übertragung in die Bauweise unserer Tage" Allgemeine Bauzeitung 11 (1846)

In his article, Jobard, a Belgian engineer and the director of the *Musée de l'Industrie belge*, prophetically announced his vision for the new iron architecture. He wrote: " Les grandes révolutions architectoniques ont toujours suivi les grandes révolutions sociales; il ne se fait que peu de changements pendant les intermèdes, quelque longs qu'ils soient. On se borne à retravailler l'ancien, . . à ressasser les ordures du passé, pour y chercher le germe des choses de l'avenir, jusqu'a ce qu'un bouleversement radical ait fait table rase des écoles et des idées banales."[380] After the long period of eclecticism, he argued, iron architecture finally came to emerge as a completely new style of the modern age.

> . . .la race de nos anciens pontifes lithomistes, devra s'éteindre comme celle des mastodontes et des plésiosaures, pour faire place à l'espèce nouvelle des artistes *sidérurgiques*, qui ne conserveront aucun préjugé traditionnel de la vieille école, puisqu'il ne l'auront point connue.
>
> Nous entrons enfin à pleines voiles dans le *style métallurgique* qui présentera des différences plus tranchées qu'il n'en existe entre le style antique et style ogival.
>
> Car les métaux se prêtent à toutes les formes que peut rêver l'imagination la plus brillante de nos artistes, si nombreux, si pleins de goût, et d'un talent si pur aujourd'hui .
>
> Tous les chefs-d'œuvre architectoniques des mille et une nuits, relégués jusqu'ici dans les albums et les keepsakes, deviennent réalisables avec la fonte et le fer. Il n'est pas jusqu'aux formidables cauchemars bibliques du peintre *Martin*, aux mystérieuses compositions brahmaniques de l'érudit *Couder*, aux élégantes arabesques de l'ingénieur *Midolle*, qui ne puissent se traduire en dentelles de fonte illustrée d'admirables verrières.
>
> Faites bien attention que toutes ces merveilles coûteront moins cher que la pierre gélive, que la brique efflorescente, que le bois éphémère, et dureront cent fois plus longtemps.[381]

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380 Jobard, "Architecture métallique," RGA (1849), col. 27: "architectural revolutions always follow social revolutions. In the interim periods, few changes are to be seen, no matter how long these periods may be. Men insist upon remodeling the old forms until a radical upset wipes the slate clean of banal schools and ideas."

381 Jobard, "L'Architecture de l'avenir," RGA (1849), col. 26 ff.

Jobard's vision of iron architecture was undoubtedly influenced by the revolutionary atmosphere of 1848. Jobard and Daly betrayed an almost blind faith in the ability of iron and the new construction technology to produce a new architecture. However, Jobard's solution to the problem of creating a new architecture without owing to the existing historical styles was altogether ineffective. The real question was how to create new forms of iron architecture. When it came to this question, they had neither specific ideas nor theories. Rationalist architects such as Daly have considered the new types of iron architecture, such as railway stations and winter gardens, somehow a model for new architecture. However, as we have seen, the architects also clearly distinguished an architectural style from mere construction. Although science and industry were essential factors, the rationalists maintained that these would not dictate the form, but sentiment should be expressed as well. During the 1840s, however, a romantic positivistic belief in the unity of science and art was dominant ideology among the avant garde architects. For example, Daly wrote in 1845, "L'univers est un, l'industrie, l'art et la science ne sont que les trois grands aspects de l'unité universelle. Ils correspondent à l'utilité, au beau et au vrai, qui sont aussi trois aspects de l'unité universelle."[382] In his "Du symbolisme dans l'architecture (1847)," Daly argued that an architectural form is a symbolic representation of the material, moral and intellectual state of humanity in the diverse epoques of its development and geometry furnishes symbols to architecture.[383] As Ann Van Zanten summarized, then, "in geometric lines of an edifice, of which the combinations are born of the need of construction and the state of science, there could be a symbolic value... the architectonic ideal of a people must be the expression of its sensibility and between the characteristic lines adopted by diverse peoples and their religious sensibility, there is a necessary relation..."[384] This approach was clearly based on the utopian positivistic

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[382] Daly, "La Science et l'Industrie, sont-elles les ennemies de l'art?" RGA (1845), col. 52
[383] See Daly, "Du Symbolisme dans l'architecture," RGA, (1847)
[384] Ann Lorenz Van Zanten, "Form and Society," Oppositions 8, (Spring, 1977) P.143

belief that there was no separation between the principles of art, or symbolic values and the principles of science and construction. In his 1846 article, thus, Daly already considered the railway station belonging to architecture as art, "le programme d'une station de chemin de fer peut offrir quelque chose de la netteté indispensable à la production d'une œuvre d'art."[385] When Hector Horeau's Jardin d'hiver was completed in 1847, Daly also wrote, considering it a work of art: "Un jardin d'hiver est éminement caractéristique de notre époque; c'est à la fois une œuvre d'industrie manufacturière, une œuvre d'art et une œuvre de culture. Un Jardin d'hiver est un rendez-vous naturel de plaisir et de science."[386]

The revolutionary atmosphere of the Republic especially made this unity of sentiment and construction look more promising. The utopian association of iron architecture with the new mass public who emerged as a new socio-economic and political subject, was clear enough to create euphoria for a new modern architecture of iron, which would express the new modern sentiment. This characteristically optimistic vision for the fusion of art and industry during the revolutionary period was also detected in Théophile Gauthier's call for the creation of a new style of iron architecture. Gauthier was an advocate of art for art's sake, which intended to save art from the encroachment of vulgar industry. However, in 1850, he wrote in La presse, calling for a new style of iron architecture. "We have searched for a long time without success to create an original architecture which is neither Greek nor Gothic, nor the mixture of the two, as was that of the Renaissance. We will succeed not in creating impossible forms on paper, but in being served by the new means which modern industry gives."[387] He continued in the article, ". . . mankind will produce a completely new architecture out of its period exactly at the moment when the new methods created by recently born industry are made use of. The

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[385] Daly, "Des gares de chemin de fer, " RGA 6 (1846-7), cols. 509- 511
[386] Daly, "Jardins d'Hiver de Paris et de Lyon," RGA (1847), col.410
[387] Théophile Gauthier, La Presse (1850). Quoted in Steiner, French Iron Architecture, p.1

application of the cast iron allows and enforces the use of many new forms, as can be seen in railway stations, suspension bridges, and the arches of conservatories."[388]

The curious merger of the romantic idea of art for art's sake, which had eliminated the concept of the social utilitarian and moral purpose from the work of art, and the purely industrial buildings of iron indicated the characteristic optimism of the revolutionary period. The unity of art and industry was received without serious doubts. So much so that even the upholders of the *l'art pour l'art* were led to a scientific kind of realism. Such realism could take the form of an avant garde which demanded that the most advanced technology be employed to arrive at a scientifically functional kind of building of the most updated sort, that is, a call for an architectural style of purely industrial construction.

However, it was only temporarily that this euphoria for the emergence of new style of iron architecture was held without reservation. Already after the uprising of the June Days, there was a rupture between affluent bourgeoisie and workers, and between bourgeois Republicans and socialist Republicans.[389] The bourgeoisie feared the radicalism of workers and sided with the conservative Republican Government. After the June Days, the Government dissolved the National Workshops of workers. As the masses, on whom the utopian socialist architects and artists had pinned their faith, fragmented into the antagonizing classes of affluent bourgeoisie and working class, the collective sentiment of the modern democratic society which they had hoped would be expressed in iron construction, could no longer exist.

The hope in the unity of art and industry and thus, in the creation of a new style of iron architecture gradually dwindled during the presidency of Louis Napoléon, who was

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388 Théophile Gauthier, La Presse (1850). Quoted in Giedion, Space Time and Architecture, p. 213

389 It is not easy to determine each architect's position in this political spectrum after the rupture bewteen affluent bourgeoisie and proletarian working class. Most liberal architects, such as Daly, Horeau, Labrouste and Viollet-le-Duc, were close to bourgeois Republicans. After the Revolution, Daly was an official candidate for the National Assembly, representing archtiects and workers, while Horeau was an independent candidate in the Seine-et-Oise. (See Lipstadt, "Cesar Daly, Revolutionary Architects? ") However, Daly and Labrouste sided with bourgeois republicans, against the workers. For example, Daly's RGA was critical of the capenter's strike in 1845 and encourged to use iron instead. Henri Labrouste enrolled the National Guards duirng the Revolution. However, a few architect such as Horeau was certainly more radical than others and stand for the proletarian cause. He participated in Paris Commun in 1870 and died in prison.

elected in 1849 and soon made himself the Emperor by a *coup d'etat* in 1851, putting an end to the short lived Republic. Republicans and Fourierests had opposed his election and as a result, Considérant went into exile in 1850 and César Daly soon left France on a journey to study in America. With this change of political situation, the euphoria during the revolutionary period also disappeared. Architects began to recognize that the unification of sentiment and industry would not be easily accomplished in the immediate future, and began to raise more realistic questions for the definition of a new language for the new material.

This changing atmosphere was already reflected in Reynaud's first volume of Traité d'architecture, which he published in 1850, with Labrouste's help. Reynaud, Professor of the École Polytechnique and a leader of the rationalist reform movement since the 1830s, also was confident that a new style of modern architecture should be derived from the new material of iron. In the section on iron in his book, he elaborated in a very clear and succinct manner the rationalist agenda of creating a new form of iron architecture:

> Le fer se recommande, . . , aux études sérieuses des architectes. Depuis longtemps, on accuse l'Architecture de ne pas renouveler les formes qu'elle met en œuvre; on prétend que nous n'avons pas de système d'architecture parce que nous reproduisons des éléments déjà connus. . . .
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> Mais, à la nouvelle matière qui vient s'offrir à nous, il[le fer] faudra de nouvelles formes et de nouvelle proportions, car elle diffère essentiellement de toutes celles qui, jusqu'à ce jour, ont été mises en œuvre. Ce qui convenait à la pierre ne saurait, sous aucun rapport, convenir au fer.[390]

As already manifest in his architectural entries in the Encyclopédie nouvelle (1834-36), Reynaud did not view science and industry as being solely responsible for the creation of an appropriate form for iron architecture. They were essential only as a guiding

390 Léonce Reynaud, Traité d'architecture, volume 1 (Paris, 1850) p. 447-8

principle, and art and sentiment, which could not be reduced to science and reason, should be expressed as well. Reynaud emphasized in the introduction to his Traité, "Ce qui touche à l'essence intime de l'art se sent, et ne s'explique pas; vouloir traduire toutes les expressions de l'architecture en langage ordinaire, serait s'en faire et en donner la plus fausse idée; tout soumettre au jugement de la raison serait ne rien lasisser aux appréciations plus délicates et souvent plus sûres du sentiment."[391] Reynaud elaborated on the guiding role of industry and science in the creation of new style:

> Il y a donc, dans le fait industriel, le principe, non pas d'une rénovation complète de l'art, mais de nouveaux éléments, d'une nouvelle branche qui est... appelée à prendre des développements considérables, aux progrès de laquelle il serait impossible d'assigner des limites. La science sera également appelée ici à exercer une influence directe sur l'architecture, et elle permettra de ne pas recommencer pour le fer les longs tâtonnements auxquels il a fallu se livrer avant de découvrir les formes et les proportions les plus convenables pour les constructions en pierres. Elle donnera immédiatement ce que, privé de son secours, nous eussions dû attendre d'une longue et dispendieuse expérience. Elle ne dictera pas des lois absolues, elle ne fixera pas des proportions harmonieuses, ce ne sont point choses de son ressort; elle ne dominera pas l'art, mais elle élaborera les bases sur lesquelles le sentiment appuiera ses créations, elle posera les limites entre lesquelles le goût de l'artiste agira librement.[392]

However, the optimism for the union of science and art that the critics possessed a year before was not present in Reynaud's writing.[393] Reynaud was already unsure of the unity of art and industry. Though he was the author of the Gare du Nord(1846), Reynaud, unlike Daly, did not consider the industrial buildings of iron as a new artistic architecture. While Reynaud seemed to retain the hope for the creation of new forms of iron architecture and thus the faith in the ultimate union of art and sentiment, and science and industry, he

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[391] Ibid., vol. 1. p. vi
[392] Ibid., p.448
[393] To my knowledge, Reynaud's activities during the Revolution has not been studied yet.

did not believe that existing iron constructions were a new art representing the public sentiments of the epoque. He wrote:

> Les essais faits jusqu'à présent ont présenté plus de hardiesse dans des constructions purement industrielles que dans celles qui sont plus spécialement du ressort de l'art. A peine, dans quelques-unes de ces dernières, la nouvelle matière a-t-elle timidement essayé de se produire sous les formes qui lui conviennent. Il n'y a point à s'en étonner; les plus grandes choses ont eu d'humbles débuts.[394]

However, more than anything else, Reynaud denounced the public euphoria for a new style of iron architecture and the utopian association between iron architecture and the public sentiment, arguing that the public's demand for a completely new style of iron was unjustified. He claimed that artistic forms concern their universality, rather than caprice or pure convention. His writing almost sounds like a direct response to Daly's writing an year earlier:

> Le public, sans rendre un compte bien net des diverses conditions imposées à l'Architecture, sent parfaitement que cet art ne peut rester étranger aux progrès des sciences et de l'industrie, et, lorsqu'il nous voit si fort au-dessus de nos devanciers, dans ces deux branches de l'activité humaine, il est en droit de s'étonner de retrouver presque exclusivement, dans nos édifices, les formes et les proportions élémentaires de la Grèce et de Rome. Les changements qu'il peut constater lui paraissent insuffisants, parce qu'il ne peut apprécier complètement le mérite des formes de nos constructions en pierre.
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> . . . .
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> Et d'ailleurs, il ne suffit pas de la puissance créatrice de l'artiste pour introduire de nouvelles formes, il faut une opinion publique disposée à les apprecier. On demande sans cesse du nouveau, mais, c'est, presque

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394 Ibid.

toujours, avec une sorte de répulsion qu'on le voit apparaître, et, pour être accepté, il faut qu'il se garde de rompre trop brusquement avec le passé.[395]

Thus, Reynaud demanded that before the creation of a new style of iron architecture, it was necessary for new aesthetics of iron to enter the public sentiment of the epoque. "Il y a donc un travail préliminaire à accomplir avant que l'architecture puisse s'approprier nettement le fer: il est nécessaire que les propriétés, les proportions, les dispositions des nouvelles constructions soient entrées dans le sentiment de l'époque."[396] He then emphasized the inevitable duration of traditional taste until the new aesthetic standard enter the sentiment of the epoque.

In 1852, in his "The Eighteenth Brumaire of Louis Bonaparte," Karl Marx analyzed the failure of the 1848 Revolution after Louis Bonaparte's *coup d'état* of December,1851. Here Marx criticized the limitation of revolutionary consciousness of the people, which constantly returned to past:

> . . . men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly found, given and transmitted from the past. The tradition of all the dead generations weighs like a nightmare on the brain of the living. And just when they seem engaged in revolutionizing themselves and things, in creating something entirely new, precisely in such epochs of revolutionary crisis they anxiously conjure up the spirits of the past to their service and borrow from them names, battle slogans ad costumes in order to present the new scene of world history in this time-honored disguise and this borrowed language....[397]

This passage was also a quite accurate critique of the limitation of the architectural situation of the time, that is, the recognition of the difficulty of creating a new form unindebted to the

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395 Ibid., pp. 448-449

396 Ibid., p. 449

397 Karl Marx, "The Eighteenth Brumaire of Louis Bonaparte," in <u>The Marx Engles Reader</u>, ed. Robert C. Tucker (New York: Norton, 1978) p. 595

past styles which was discussed by Reynaud. As Marx pointed out, under the weight of traditional aesthetic customs, the new material condition could not create completely new forms. Marx attributed this to the limitation of revolutionary consciousness, constantly returning to the past. Presumably, he related this limitation to the bourgeois ideology of unscientific consciousness of utopian positivism, which believed that modern science and industry could create a new harmonious social order and new aesthetic form by themselves only if they were properly organized. In the Communist Manifesto published in 1848, a short time before the June Revolution in Paris, Karl Marx had already criticized utopian socialists' positivistic vision of harmonious technological society, arguing that as long as the capitalistic relations survive, the technology is fettered to capitalistic commercialism. Discussing the political problem of ownership and power, which was considered prejudicial to any change in working class conditions, he argued that every partial reform, realized within the framework of the capitalist system, would develop into a confirmation of this system and must be regarded as completely invalid.[398]

Marx's brand of socio-economic determinism that a new style could not emerge until the social and technological revolution completely changed our consciousness, did have a certain explanatory power at that historical moment, but not for the whole history thereafter. This position disregarded the fact that architects nonetheless constantly searched for a new style of the nineteenth century, reacting to the new material conditions and investing a certain meaning in them, and thereby playing a certain social, ideological role.

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398 Leonardo Benevolo, The Origins of Modern Town Planning (Cambridge, Mass: MIT Press, 1982) p. 107. In fact, in the latter part of the 1840s, there was disenchantment with bourgeois positivism. In the mid-1840s, Auguste Comte, the former secretary of Saint-Simon, had developed positivism by taking away the romantic, quasi religious aspect from the Saint-Simonism. He published Discours sur l'esprit positif in 1844, postulating that the material happiness of the people would result from the development of positive science and reason. Positivists thus searched for social arts instead of pure arts. However, in 1851, Auguste Comte, who advocated the scientific positivism and refused by Saint-Simon as ignoring sentimental and religious aspects of human nature in the 30s and 40s reintroduced the concept of art in his theory. Comte later emphasized the moral authority and the role of art against the liberal individualism. Although Comte eliminated romantic aspects of Saint Simonism in favor of positive concept of science, he added the value of art as a embellishment, as a ideal representation of what it is. This was the Academy's concept of art and thus, his theory prefigured the separation of art and industry and loss of utopia during the seceond half of the ninteenth century.

In this respect, Walter Benjamin's application of the material dialectics to the level of consciousness was a significant step forward to understand architecture. Although the iron buildings were mixed with traditional tastes, Benjamin argued that these new forms of industrial mass culture, as a source of dialectical imagination, had an instant of utopia which had its store place in the collective unconscious.[399] He theorized it in this way:

> Corresponding in the collective consciousness to the forms of the new means of production, which to begin with is still dominated by the old (Marx), are images in which the new are intermingled with the old. These images are ideals, and in them the collective seeks not only to transfigure, but also to transcend, the immaturity of the social product and the deficiencies of the social order of production. In these ideals there also emerges a vigorous aspiration to break with what is out-dated which means, however, with the most recent past. These tendencies turn the fantasy, which gains its initial stimulus from the new, back upon the primal past. In the dream in which every epoch sees in images the epoch which is to succeed it, the latter appears coupled with elements of prehistory- that is to say of a classless society. The experiences of this society, which have their store-place in the collective unconscious, interact with the new to give birth to the utopias which leave their traces in a thousand configurations of life, from permanent buildings to ephemeral fashions.[400]

Although these new forms of iron construction were a dream image as Benjamin called it, which was chained to the capitalistic modes of production, it redeemed the desire for utopia to which "humanity has persistently given expression."[401] Benjamin argued that this utopia was none other than the communist goal stated by Karl Marx in 1844 in "Economic and Philosophic Manuscripts": the harmonious reconciliation of subject and object through the humanization of nature and the naturalization of humanity. While the iron constructions were perhaps residues of a dream world of utopia, the conscious effort to create a new

[399] See Walter Benjamin, op. cit., p. 148
[400] Ibid. p. 159.
[401] Ibid.

style, if not a utopia, of the nineteenth century with new material and technology, the image of a unified culture, continued as a dominant bourgeois ideology during the second half of the nineteenth century.

After 1851, thus, the problem of the artistic forms of the new material and the construction technology became a central issue. Architects and critics began to search for artistic forms that would correspond to the modern material and technology. In these attempts to synthesize industry and art, and technology and form, we witness the beginning of the rationalist discourses on architecture which went on throughout the second half of the nineteenth century. On the one hand, the movement to search for a new style of iron became a more decorative formal and linguistic endeavor. This change of the situation was already manifested in de Laborde's reflection on the London World Exposition in 1851, where he criticized the industrial products and their styles. Thus, a movement which attempted to combine art and industry in search of a new language for industrial production, began. In England, Owen Jones, in his Grammar of Ornament, published in 1856, searched for an entirely new language. Hector Horeau also developed a non-classical model of ornaments and new proportions in his later projects. He became more interested in the liberal decorations, while his early iron buildings, such as the Jardin d'hiver and the Chateau de fleur, were extravaganzas of un utopian fairly tale. In this context, on the other hand, with their structural theory of architecture, Viollet-le-Duc and Gothic rationalists emerged as main figures in architectural rationalism during the 1850s and 60s. The creation a new artistic form of modern architecture in the separation of technology and form, however, was the fundamental dilemma that architectural rationalism had to deal with, but which could not be easily solved by architectural theories alone. In the next chapter, I will discuss the dilemma of the rationalist agenda of producing a new architectural style in the context of the separation of art and industry.

Part III

Iron Architecture and the Dilemma of Bourgeois Rationalism, 1852-1889

Chapter Seven: Rationalist Alternatives of Iron Architecture and Their Dilemmas, 1848-69.

The Separation between Art and Industry: From Rationalism to Eclecticism.

As discussed in the previous chapter, after the failure of the 1848 Revolution, the positivistic and utopian belief in the unity of science and art, and thus in the creation of a new style of iron architecture declined. While iron construction continued to develop and be used in architecture during the Second Empire, there was no utopian sentiment attached to it, and it came to be seen once again as an industrial material devoid of artistic sentiment.[402] French architects' responses to the Crystal Palace, built for the first World Exposition in London in 1851, already testified to this changing position about iron. For example, in his review of the Exposition in Revue générale de l'architecture, an architect and engineer Henri Sirodot called the Crystal Palace a "*serre gigantesque*" rather than proper architecture.[403] (fig. 81) In his report, Comte Léon de Laborde, a French delegate to the Exposition, criticized the industrial decorative arts exhibited in the Exposition as lacking in artistic taste. As a result, in the 1855 World Exposition held five years later in Paris, the French proudly included a fine arts section in the Exposition and dressed the iron interior of the Exposition hall with a permanent monumental stone architecture.(figs. 82, 83) Here, of course, there was a national rivalry between the two countries; the French

[402] Napoléon III encouraged iron constructions as we can see in the process of the construction of *Les Halles*. The reason was in part the rivalry with England, and in part his policy of industrialization.
[403] Henri Sirodot, "Exposition de l'Industrie Universelle à Londres," RGA (1851), p. 154.

certainly considered themselves artistically superior and wanted to demonstrate it.[404] However, as already discussed, their desire to embellish iron buildings and industrial products with "art" certainly appeared after 1851, when the hope of expressing the collective sentiment of modern democratic society, and thus creating a new modern architectural style of iron, became obsolete.

The introduction of art to industry, thus, became a central theme in rationalist architectural discourses during the Second Empire. However, in the absence of a collective idea and artistic sentiment which could be associated with iron, this was not an easy task. During the Second Republic, positivism in art and architecture was prevalent among architects and artists. They believed that an industrial form would somehow express an artistic sentiment of the period. This sentiment was a kind of collective idea of society which was to be revealed in its particular system of construction. The concept of art in architecture was, thus, not something that was separate from and imposed on the construction, but something inherently related to it. However, after the collapse of utopia, the concept of art was already separated from material reality, and artists had retreated into their own spiritual world as a protest against the bourgeois vulgarity, developing purely subjective and ideal theories of art based on the artistic genius of individual artists. Théophile Gautier, for example, who had enthusiastically hoped for a new iron architecture in 1850, became a strong proponent of art for art's sake. Beginning in 1852, Charles Blanc, director of the Beaux-Arts during the Second Republic (1848-1851), developed a purely subjective theory on the communication of art.[405] By the end of the 1850s, many artists strongly desired to create an artistic domain which would be completely free from the encroachment of modern industry. With the separation of art and modern industry, architectural rationalism, which believed that a characteristic system of construction of a

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404 Even Viollet-le-Duc claimed London a Babel tower of modern industry after his visit to London in 1855.

405 Blanc developed his theory of art in articles serially published in the Gazette des Beaux-Arts from 1860 to 1866, which he founded in 1859. These were published as a book, Grammaire des arts du dessin in 1870.

particular period necessarily embodied the artistic sentiment of the same period, became ambiguous.

The development of modern science and engineering during the 1850s also rendered the architectural rationalism increasingly obsolete. Until the mid-nineteenth century, architects such as Hittorff and Labrouste had designed the iron structure of their architecture by themselves.(e.g., the Circus de Panorama and the Bibliothèque Ste-Geneviève) However, after 1852, with the advance of mathematical methods for calculating the structural members of iron, the gap between architecture and engineering became wider. (fig. 84) As one could see in public iron buildings such as railway stations and market halls, built during the Second Empire, design of iron structures became completely separated from that of architecture.(e.g., the Gare du Nord) (fig. 85) Architects trained in the Ecole des Beaux-Arts, devoid of engineering education, could not catch up with the progress of modern structural mechanics and thus, in most cases, they remained as decorative designers of the architectural facades of the buildings.

It seemed inevitable then that the rationalists of the 1840s such as César Daly and Léonce Reynaud would turn to classical or eclectic tastes.[406] While iron structures continued to be employed in large public halls for practical reasons, the selection of architectural styles became plainly eclectic, which, in turn, became a dominant architectural principle of the Second Empire especially during the Haussmannian urban renewal. This change of the rationalists' position was most dramatically reflected in Reynaud's second volume of Traité d'architecture which was published in 1858, eight years after the first

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406 A few architects such as Sirodot, however, were still voicing the positivistic rationalist belief in 1853. For example, Sirodot argued in his series of articles on "Les planchers en fer": "Notre siècle est bien un siècle de fer. . . . le caprice de la mode, qui sur tout étend son empire, même sur l'emploi de ce rude métal, si peu fait, en apparence, pour attirer l'attention de la frivole déesse. Mais ce caprice évanoui, il restera, pour motiver l'usage du fer, la satisfaction d'une besoin légitime, dans tous les temps, et de nos jours plus impérieux que jamais; C'est l'économie, qui se traduit également par ses termes: sécurité, rapidité, ou par ceux ci: économie de temps, économie d'argent . . . Nous voulons seconder de tous nos efforts les tentatives de l'art pour trouver des voies nouvelles, aider de tout notre pouvoir les premiers mouvements de ce squelette de fer qui, pour se révéler dans toute la majesté de ses glorieux devanciers, n'attend sans doute qu'un souffle de foi et de génie." "Industrie du Bâtiment, Planchers du fer," RGA (1853), col. 342

volume, and was highly praised by the Academy.[407] There, the hope for the future of iron architecture that had been expressed in the first volume was replaced by a greater emphasis on classical aesthetic principles.[408]

César Daly, a supporter of iron architecture during the 1840s, also changed his position after 1853, and systematically advocated eclecticism. Before 1850, Daly and his journal Revue Générale de l'Architecture held a positivistic belief in the progress of architecture and in the emergence of a new style derived from the unity of reason and sentiment in modern society. [409] However, after the collapse of the utopia, his earlier confidence in science, commerce and industry, and his belief in the unity of technological forms and artistic sentiment disappeared. Hittorff's Panorama, to which the RGA had given full coverage in 1841, was described in 1855 as a "curious construction."[410] His interest changed from positivistic rationalism to historical references and to formal aesthetics.

While the rationalists of the 1840s became eclecticists, or turned to classical aesthetics, the Gothicists maintained the rationalist position and continued to attempt to create a new style of modern architecture with iron. It seems quite logical that the Gothic rationalists fell into the mainstream of rationalism, given that a historical reference was inevitable in creating a new style with a modern material such as iron. Because the Gothicists had argued the Gothic to be the most advanced and the most rational system of construction of the various historical styles, it was natural that they believed that the Gothic was the single best model to start with.[411] However, in the absence of collective sentiment

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407 The members of the Academy, Gilbert, Hittorff and Duban, et al published a laudatory review of Reynaud's Traité d'Architecture in Le Moniteur Universel, 14 (Dec. 1858)

408 It was Pevsner, to my knowledge, who first pointed out the change of Reynuad's position. See Nikolaus Pevsner, "Viollet-le-Duc and Reynaud," in Some Architectural Writers in the Nineteenth Century (Oxford: Clarendon Press, 1972) p. 206

409 For example, in his article, "Du Symbolisme dans l'architecture," Daly had argued that an industrially produced new form embodies a symbolic expression of human sentiment. RGA (1847), cols. 49-64

410 See Daly, RGA (1855), cols. 120-125

411 Viollet-le-Duc and Reynaud have been compared and analyzed by many scholars such as Pevsner and Middleton. However, their difference was discussed mostly in terms of their different preference for style, either Classic or Gothic, with the same rationalism (See Robin Middleton. "Rationalist Interpretations of

associated with iron, and with the growing alienation of art and industry, how could iron, an industrial material, be aesthetically used to create a monumental, artistic architecture? Louis-Auguste Boileau's projects for iron churches in the early 1850s became a testing ground for iron's capability to create a new style of architecture in this respect.

Gothic Rationalism and Iron Architecture: Debates on Boileau's Iron Churches

Louis-Auguste Boileau, an auto-didact who was trained in neither an architectural nor an engineering school, was a constructor of Gothic buildings during the early 1840s. His buildings could be seen as examples of the early Gothic revivalism led by Didron and Mérimée. However, Boileau took seriously the conclusion of the 1846 debates between the Classicists and the Gothicists that a modern church should be the creation of the nineteenth century, neither a copy of the Gothic nor of the Classic. Boileau soon disagreed with the revivalism of the Gothic for a modern religious building, and separated himself from the Gothic revivalists. As he wrote later in 1853, he became convinced that "l'architecture monumentale doit marquer notre époque d'un cachet caractéristique."[412] Then, in 1850, after the Revolution, he came up with the idea of the *Cathédrale synthétique,* or *Composition synthétique adaptée à un monument religieux de l'importance de Saint-Pierrre de Rome*, as an original system of modern religious architecture of the nineteenth century, which was neither eclectic nor archeological revivalism.(figs. 86, 87, 88, 89) He described his intention in Histoire Critique de l'Invention en Architecture, published in 1886: "Il s'agit de mettre un terme à l'anomalie tant raprochée à notre siècle d'être le seul qui n'aurait pas ce qu'on appelle communément un style d'architecture."[413]

Classicism of Léonce Reynaud and Viollet-le-Duc," in AA Files II (1986) and also Pevsner, "Viollet-le-Duc and Reynaud") My argument is that the different paths of these two theorists should be understood in terms of the dialectics of bourgeois positivism. While Reynaud, who had argued for positivistic scientific discipline of architecture and new style of iron architecture, later became a classical eclecticist, Viollet-le-Duc, who was a main figure of Gothic rationalism, later became an advocate of iron architecture.

412 Louis-Auguste Boileau, La Nouvelle forme architecturale (Paris: Gide et Baudry, n. d. 1853) P. 3

413 Louis-Auguste Boileau, Histoire critique de l'invention en architecture (Paris: c. Dunod, 1886) p. 98

In the explanation of his iron churches in Nouvelle Forme Architecturale (1853), Boileau stressed that a historical reference was inevitable to create a new system of modern religious architecture. However, opposing both the eclecticism of Classicists and the archeologism of Gothicists, Boileau argued that a system of construction continuously progresses. He wrote :

> Dans l'ordre des travaux humains un progès n'est pas autre chose qu'une nouvelle puissance ajoutée à la masse des acquisitions déjà faites par les devanciers. . . [il faut] déterminer les différents types architectoniques qui marquent les différents termes de la progression de l'art monumental, et établir la série, constater le point le plus élevé que cet art ait atteint, pour s'élever plus haut encore.[414]

Boileau saw history as three distinctive phases of progress, each synthetic phase having its own system of construction which was also the expression of its own sentiment and passion.[415] The modern Christian phase, which had started from the Gothic, was still in the process of evolution. As for the weakness of the Gothic, he shared with the Classicists the opinion that flying buttresses not only caused inconveniences in terms of unity and brightness of space, but also represented its structural weakness.[416] He then considered his church a perfection of a universal system of construction of the third stage of the synthetic phase. Therefore, although his system of construction was conceived as the perfection of Gothic system, it was to be a completely new system which would be neither a copy of the Gothic nor eclectic. Boileau's new system of construction was certainly a very original and successful attempt to overcome the limitations of both eclectic historicism of Romantic rationalists and Gothic archeologism of Gothic revivalists. When

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414 Louis-Auguste Boileau, La Nouvelle forme architecturale (Paris: Gide et Baudry, n. d. 1853) P. 3

415 Boileau mentioned Buchezian theory in the HCI, p. 33: "L'hypothèse générale de Buchez est celle qui répond le mieux à la vérité des faits." Buchez's book, Introduction à la science de l'histoire ou du développement de l'humanité,(Paris: Paulin, 1833) was published in 1833.

416 See Boileau, NFA, p. 12

Boileau proposed a church with cast iron column in the Chaussée-d'Antin in La Presse in 1854 and then in L'Illustration, (fig. 90), Albert Lenoir, a disciple of Labrouste and one of the romantic rationalists who worked with Vaudoyer in search of a modern system of religious architecture during the 1840s, praised the originality of Boileau's system, suggesting its possible use for architecture which required a vast space, such as the *Palais de l'Industrie*.[417]

L.-A. Boileau's original model of 1850, however, was designed in stone. The first mention of iron appeared as a note in 1853 when Boileau published his proposals for churches in Nouvelle Forme Architecturale: "Depuis la rédaction de ce programme, il a été reconnu qu'on pouvait, si on le voulait, substituer la fonte et le fer à la pierre."[418] It is believed that Michel Chevalier, who had envisioned the Saint-Simonian iron temple in the 1830s, and Albert Lenoir influenced this development.[419] But as discussed in the previous chapter, iron, coupled with the utopian idea of mass democracy associated with it, had already emerged as a determinant factor in the creation of new architecture in the late 1840s.[420] In fact, Boileau envisioned the *Cathédrale Synthétique* not only as a solution to the problem of modern religious architecture, a question which had fired the debates between Classicists and Gothicists in 1846, but also as a response to the utopian aspiration for a temple for a universal religion during the revolutionary period.[421] Boileau had participated in the 1848 event in Paris and reappeared in 1850 with the idea of the *Cathédrale Synthétique*.[422] Therefore, the merging of a utopian architectural project for a religious building and iron construction was to be expected in this socio-cultural milieu.

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417 Albert Lenoir, "Projet d'Église pour la paroisse de Saint-André, dans la Chaussée-d'Antin, par M. Boileau, Architecte," Illustration, (Feb. 1854)

418 Boileau, NFA, p. 19

419 Bruno Foucart, "La Cathédrale Synthétique de Louis-Auguste Boileau," Revue de l'Art, vol. 3 (1969) p. 58

420 See Jobard, RGA (1849); Reynaud, Traité..., (1850); Sirodot, RGA (1853).

421 Boileau's romantic utopianist vision was clearly shown in his emphasis on lighting in his proposal.

422 See Bruno Foucart, op. cit., p. 50

L.-A. Boileau's design of iron churches was literally the first attempt to apply iron construction to monumental religious building. Indeed, it was the first materialization of the rationalist aspiration to apply iron to a religious monumental architecture in order to create a new modern style. In presenting the new universal system of iron architecture, Boileau himself took up the rationalist argument that rationalist architects such as Daly and Reynaud had espoused in the late 1840s. Boileau wrote in NFA:

> On suppose généralement qu'on copiera avec la fonte les formes consacrées pour la pierre. S'il devait en être ainsi, je serais le premier à repousser un contre-sens tout aussi déplorable... Je suis de l'avis de ces hommes de goût qui veulent qu'on accuse franchement chaque matière pour ce qu'elle est et qu'on la traite selon ses propriétés.[423]

In 1853, Boileau's design of an iron church was reviewed by the Conseil des Bâtiments Civils, led by Gourlier, Biet and Gisors. The committee recognized the novelty of Boileau's constructive system. However, they did not appreciate Boileau's claim that he had created a new religious architecture, embodying modern religious sentiment. With its bizarre appearance, contradicting all the received ideas concerning the aesthetic standards of architectural styles, the iron church looked strange to the contemporaries. Gourlier wrote in the Bâtiments Civils' report: "Cette succession continuelle de plans différents... ne semblerait - elle pas contraire à ces données de simplicité, d'unité qui ont fait la force, le principe de toutes les conceptions artisques."[424] The architects of the Conseil des Bâtiments Civils also believed that the elimination of buttresses and pointed arches, which were the inevitable result of the use of iron, deprived the church of the symbolic upwards

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[423] Boileau, La Nouvelle forme architecturale (Paris: Gide et Baudry, n. d.1853) p.34

It is generally supposed that cast iron will copy the forms established for stone. If that were to be the case, I would be the first to reject so deplorable a misconception. But I should like to say immediately that being an enemy of all lies in architecture, I should never accept one that seems so inexcusable. I share the opinion of those men of taste who think that one should frankly accentuate every material for what it is and treat it according to its properties.

[424] Cited in Boileau, NFA, p. 56

movement of religious buildings. Thus, the church returned to "le principe d'horizontalité consacré pour les voûtes des cathédrales" and became "*halles basilique*," losing religious significance.[425] Gourlier wondered in the report if "la légèreté, la ténuité de ce nouveau mode d'exécution était conforme à ce que tout édifice sacré réclame de majestueux et d'imposant."[426] Thus, while the Saint-Simonist critics, Edouard Charton and Chevalier, Romantics such as Lenoir, Vitet and Mérimée, and engineers supported Boileau's design because of its innovative constructive system, the architects of the Conseil des Bâtiments Civils refuted his claim that his iron church materialized a temple for a universal religion, embodying modern religious sentiments.

However, Boileau soon had a chance to build an iron church, applying his principle. During the Second Empire, the church played a counter-revolutionary role to stabilize the social unrest; thus, there was a political need to build as many churches as possible. Rapid construction was required and iron was the most economic and efficient material available in terms of construction time, price and roofing system. In 1855, Louis-Adrien Lusson, a disciple of Percier and Fontaine, made a proposal for the construction of iron churches to the archbishop of Paris. His design was basically a Gothic church translated in iron.(figs. 91, 92) Lusson claimed in his proposal that the Gothic is the most appropriate style for an iron church. He wrote: "Pour mettre en harmonie la décoration des petits piliers[of cast iron], j'ai cru convenable d'employer l'architecture gothique dont l'élégance se lie assez bien avec cette pensée et dont le style en général convient aux monuments religieux." [427] His proposal was accepted by the archbishop of Paris and the work soon began. However, L.-A. Boileau, as the original inventor of iron churches, protested strongly, arguing that Lusson had plagiarized his idea. Boileau finally took the commission and completed the church of Ste-Eugène in 1855.

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425 Ibid.
426 Ibid., p. 53
427 A.-L. Lusson, Plans, coupes, élévations et détails de l'église de Sainte-Eugène (Paris: by the Author, 1855) p. 3.

In constructing the iron church of Ste-Eugène, however, Boileau had to compromise with reality. The program required to "construire une église dans le style de la fin du XIIIe, mais en employant le fonte et le fer pour remplacer les piliers et les nervures en pierre."[428] Besides technological difficulties in realizing his original constructive system, it was probably in response to the Conseil des Bâtiments Civils' criticism of Boileau's earlier proposals that the thirteenth century Gothic style was adopted as a model for the iron church. In designing the church, Boileau respected the program, substantially modifying the original system that he had proposed in 1853. In 1886 he wrote about his method:

> L'imitation de l'architecture gothique étant alors recherchée pour les édifices religieux, les principales conditions du programme furent les deux suivantes: 1) Tirer parti des avantages que comporte la construction en fer pour utiliser un terrain coûteux et restreint, en livrant aux fidèles le plus d'espace possible, et en outre pour obtenir l'économie imposée à un fondateur n'ayant à sa disposition que des ressources privées. 2) combiner la construction en fer de manière à reproduire, surtout à l'intérieur, les formes décoratives du style gothique.[429]

Boileau specifically mentioned the piers of the church of Saint-Martin des Champs as a model for the iron columns of the church of Ste-Eugène.(fig. 93, 94) He justified his design by arguing, like Lusson, that the slenderness of iron could be easily adopted to Gothic decorations. He wrote:

> . . . pour les colonnes isolées, un type exceptionnel, résultant d'un tour de force accompli en pierre par les constructeurs du moyen âge, fournit un modèle tout à fait applicable à la fonte. Grâce à leur allure métallique, les colonnes monostyles, en pierre, de l'ancien réfectoire de Saint-Martin des

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428 Delbroucq, <u>l'Église Saint-Eugène à Paris vues et description</u>.(Paris: H. Lebrun et Cie, 1856) p.10. Cited in Foucart, op. cit., p. 58
429 Louis-Auguste Boileau, <u>Histoire critique de l'invention en architecture</u> (Paris: C. Dunod, 1886) p. 134.

Champs paraissaient tellement appropriées à l'échelle d'une ossature ferronnerie si elles étaient reproduites en fonte, qu'elles furent admises à Saint-Eugène.[430]

Consequently, while iron was employed for practical and economic reasons, its architectonic possibilities that Boileau originally claimed to have achieved in his 1853 proposal, were not carried through in the church of Ste.-Eugène. Although there were many original aspects in his design, especially in the plan and the interior, which resulted from his original translation and synthesis of various forms of religious buildings of the past, in terms of style, the church was simply a copy of the thirteenth century Gothic.[431] (fig. 95, 96)

The church of Ste.-Eugène caused a serious debate between Boileau and Viollet-le-Duc, the leading theorist of Gothic rationalism, even before its completion. It started with Viollet-le-Duc's critical response to Michel Chevalier who wrote an enthusiastic article in 1855 in favor of the Boileau's church of Ste-Eugène which was then under construction. In his article, published in Journal des Débats, Chevalier supported Boileau's idea that the *convenance* of iron and that of Gothic system were intimate and thus, the Gothic fit best the model for an iron assembly hall.

L'architecture gothique, par sa légèreté relative, par le plaisir qu'elle trouvait à éviter la pierre, à la réduire à sa plus simple expression et à lui donner dans le détail des formes contournées, dentelées et à jour. . , était un appel à des matériaux differents, plus maniables et très résistants. C'était en quelque sorte la prédiction des constructions en fonte et en fer.[432]

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430 Ibid.
431 For a detailed discussion of the original aspects of Boileau's church, see Foucart, op. cit., pp. 60-61
432 Michel Chevalier, "Exposition Universelle, le fer et la fonte emploiés dans les constructions monumentales," Journal des Débats (June 1, 1855)

Enumerating what he thought were the weaknesses of Gothic system, such as a narrow span and darkness of the interior space, Chevalier went on to argue that Boileau's church substantially improved them by using iron. He even suggested that other churches at Moulins and Marseilles whose construction had just begun, should use iron as well.[433]

Viollet-le-Duc immediately responded to Chevalier's article in Encyclopédie d'architecture in 1855. He had two points: First, he disagreed with Chevalier's understanding of the Gothic and criticized it point by point. As discussed in the previous chapter, beginning the late 40s, Viollet-le-Duc studied Gothic architecture, focusing on its structural rationality, and published articles on Gothic architecture in Annales archéologiques. In 1854, one year before the construction of Ste.- Eugène, Viollet-le-Duc began to publish his rational analysis of Gothic architecture in Dictionnaire Raisonné de l'Architecture Française du XIe au XVIe Siècle, (10 vols. Paris, 1854-68). His understanding of the Gothic was different from that of Boileau and Chevalier. While Boileau saw Gothic system as the beginning of modern architecture of the third organic period yet to be perfected by the use of iron construction, Viollet-le-Duc insisted that the Gothic was already a perfected system without any possibility of further improvement; its structural equilibrium was not only rational but also beautiful.[434] For Viollet-le-Duc, all architects had to do in order to create modern architecture was, thus, to find the rational constructional logic underpinning Gothic structure in its purest state and to apply them to modern conditions. In the introduction of Dictionnaire,(1858) he explained:

> If we recommended studying previous centuries before the period when they abandoned their natural path, it is not because we hope to see the houses and places of the thirteenth century built during the present era, rather it is because we felt that this study might endow our architects with

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433 Ibid. " Plaise à Dieu qu'il soit temps encore de profiter du jet de lumière sorti de cet heureu essai pour les cathédrales de Moulins et de Marseille qui viennent d'être commencées, mais qui, si l'on se condamne à l'emploi exclusive de la pierre, ou seront de dimensions étriquées et sans style, ou réclameront des trésors que le budget ne saurait fournir."

434 See Viollet-le-Duc's entry "Construction," in Dictionnaire Raisonné de l'Architecture Française du XIe au XVIe Siècle, 10 vols (Paris, 1854-68)

some of their finesse, that aptitude of applying a principle to everything, that active originality and finally, the independence that comes from our national genius.[435]

Second, Viollet-le-Duc held a different opinion from Boileau and Chevalier as to the application of iron for the creation of modern architecture. He did not reject the use of iron for future architecture altogether; rather, he recognized that iron would be the most important material for future architecture. He wrote in his criticism of Boileau in 1855, "nous sommes loin de prétendre que l'emploi des métaux dans la bâtisse ne soit bien tiôt une immense ressource. . . On a couvert la plupart des gares de chemin de fer, des marchés, avec des charpentes soit en fer et fonte, soit en fonte seulement, soit en fer étiré."[436] Viollet-le-Duc also shared with Boileau and Chevalier the opinion that the Gothic should be the most important historical reference in the creation of modern architecture. What he disagreed, however, was Boileau's intention to use iron with a view to perfecting Gothic architecture. Since he perceived the Gothic as an already perfected system, it was not possible in the first place to improve it by using iron construction . Therefore, the iron structure of the church of Ste.-Eugène appeared to him simply as an imperfect imitation of a Gothic vault with iron.

Instead, Viollet-le-Duc argued that an architectural form should be derived from the natural properties of the material and the means of construction employed. Thus, the application of iron to architecture should be more rational and correspond to its material properties, rather than a copy of Gothic forms. He wrote:

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[435] Viollet-le-Duc, " Preface," Dictionnaire, Translated in "Introduction," by Barry Bergdoll in The Foundations of Architecture, translated by Kenneth D. White, p. 16.

[436] Viollet-le-Duc, "A. M. Adolf Lance," Encyclopédie d'Architecture (1855), col. 83
Thus, there was an ingredient of truth in Boileau's criticism of Viollet-le-Duc as "an unfair tactic of the judges in the field which consists of blaming us for not doing enough, and for not being as radical in the adaptation of form to material as we would like to be, while at the same time they prevent us from doing more." Boileau, "Réponse à M. Viollet-le-Duc," Encyclopédie d'Architecture (1855), col. 102.

Quant aux ogives, aux colonnes gothiques moulées en fonte, aux meneaux découpés à la façon de ceux du moyen âge, ce sont là des puérilités d'assez mauvais goût; ce qui convient à un art ne convient pas à un autre; les formes qui conviennent à certains matériaux ne conviennent pas à tous indifféremment; les véritables novateurs. . . produisent des formes qui ne sont que la conséquence de la matière mise en œuvre, du besoin rempli, du lieu, du goût dominant.[437]

As an example of the inappropriate application of iron, Viollet-le-Duc took particularly the cast iron columns of the church of Ste.-Eugene, which imitated the ancient Abby Saint-Martin-des-Champs: "Il ne faut pas donner au fer fondu l'apparence de la pierre, c'est qu'en changeant les matériaux, il faut changer les formes. . . , pour un novateur, la fonte et le fer laminé ou étiré permettent l'emploi de formes complétement nouvelles. Pourquoi des arcs, quand on peut avoir des poutres de fonte ou de tôle d'une énorme portée? [438] He also pointed out the problems created by the mixture of different materials such as stone and iron and by the exposure of iron to the exterior: ". . . dans les changements brusques de température, c'est une grêle de tête de boulon; pendant la pluie, un torrent d'oxyde de fer, malgré la peinture"[439] In short, Viollet-le-Duc's point was that the application of iron to monumental architecture such as churches should be more careful and it should require more time and more experiments until a satisfactory result could be reached.[440]

In the next issue of the Encyclopédie d'architecture, Boileau responded to Viollet-le-Duc's criticism with vigor. He argued that what Viollet-le-Duc asked for was actually what he intended to accomplish in his iron church of Ste.-Eugène. He maintained that there was in fact no difference between what he had done in his church and Viollet-le-Duc's claim that one should search for a rational form appropriate for iron. While Viollet-le-Duc argued that Boileau's church was a copy of the Gothic, Boileau claimed that his use of the

[437] Ibid., cols. 85-86.
[438] Ibid., cols. 109-110
[439] Ibid., col. 109
[440] Ibid.

Gothic style as a model was only a starting point. As he later writes, "là où les gothiques ont dû s'arrêter, les modernes peuvent passer, ils renouent avec la tradition interrompue au XVI siècle."[441] Thus, although it was true that he used Gothic style, he argued that he nonetheless made a great step forward by using iron, significantly improving it: "La reproduction de l'art du Moyen âge ne doit être acceptée que temporairement, comme une étude pratique destinée à renouer les fils brisés de la tradition pour se frayer un chemin dans l'avenir et trouver les éléments d'un art contemporain."[442] Viollet-le-Duc's dissatisfaction, thus, Boileau complained in his response, was probably due to the inexactness of his church in copying Gothic style.[443] In his response to Boileau, however, Viollet-le-Duc brought up Boileau's own statement on the rational principle quoted earlier. He pointed out, with justice, that Boileau's church contradicted his own rationalist statement made in the 1853 pamphlet that new material required a new form based on its natural properties and the method of construction.[444]

In the end, Boileau's attempt to create a monumental architecture with iron faced criticism from both sides. When Boileau presented a new rational system of iron construction, architects of the Conseil des Bâtiments Civils criticized it, saying it made a religious building look like an iron public hall. The adaptation of a Gothic style was then an inevitable choice to make an iron building look more spiritual than industrial. However, when he built the iron church, adopting the Gothic model, it was criticized by rationalists such as Viollet-le-Duc for not being rational in the use of iron.

The conclusion of Boileau's rationalist attempts was, therefore, as Bruno Foucart pointed out in his seminal essay on Boileau, the secularization of iron construction. Iron was a secular material appropriate for public iron halls, not for religious or monumental buildings; the mixture of the secular and the sacred, or the spiritualization of iron

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441 Louis-Auguste Boileau, Le Fer, Principal élément constructif de la nouvelle architecture (Paris: by the author, 1871)
442 Ibid.
443 Boileau, "Réponse à M. Viollet-le-Duc," Encyclopédie d'architecture, (1855), p.102.
444 See note 388.

construction was then impossible. One could either build with iron utilitarian public halls which were not considered true architectural art, or give up the ambition of employing iron to create a new style of monumental architecture. In fact, what Lenoir and Chevalier praised Boileau' church for in their euphoric articles was the utilitarian aspect of iron architecture, rather than its monumental aesthetics.[445] Lenoir had suggested that Boileau's system of construction was not only applicable to churches but also "il convient à tous les édifices dans lesquels l'espace intérieur doit être complètement libre; l'application qui en a été faite à un vaste projet destiné au Palais de l'Industrie, démontre les grandes ressources qu'il pourrait offrir pour ce genre d'édifices."[446] Chevalier also stressed the utilitarian merits of Boileau's iron church. He wrote:

> L'explication de la grande économie avec laquelle M. Boileau a élevé Saint -Eugène est facile à donner; . . . La masse des matériaux à élever à une grande hauteur est diminuée. Les voûtes sont plus légères que dans une construction gothique ordinaire. . . Enfin la charpente en fer charge très peu les voûtes. Dans ces conditions, on a pu sans compromettre la solidité, supprimer tout l'appareil des contreforts et des arcs-boutants, et réduire même l'épaisseur des murailles.[447]

Boileau himself soon accepted iron's lack of monumentality. While he continued to build iron churches in the Gothic style, in later projects, he proposed iron public halls without any pretension that they were monumental.(fig. 97) His laudatory comment on the Palais de l'Industrie of 1855, where the iron interior was enveloped with a monumental stone structure, clearly showed his changed position on the role of iron in monumentality of architecture. Boileau wrote in 1871: "Par les grandioses dispositions architectoniques et la puissance des effets de perspective qu'il recèle intérieurement, il justifie la prétention de

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[445] Chevalier, "Exposition Universelle: le Fer et la Fonte emploiyés dans les constructions monumentales," in Journal des Débats (June 1, 1855).
[446] Lenoir, op. cit.
[447] Chevalier, op. cit.

ses auteurs à la grande architecture, bien que ses couvertures vitrées, à la manière des serres jardinières, lui enlèvent tout caractère monumental."[448]

To sum up, Boileau's attempts to use iron in order to create a new style of modern religious architecture only revealed the fundamental limitations of iron construction. In his essay, Bruno Foucart well summarized these limitations:

> En considérant que le fer, volontiers utilisé à titre d'appoint dans les édifices religieux, ne devait trouver son plein emploi que dans les constructions civiles, en jugeant dérisoire le besoin de spiritualiser les formes de ce matériau, la voix publique ne décidait pas seulement du destin du fer, elle jugeait inutile la création d'une nouvelle architecture religieuse dont le siècle décidément n'éprouvait pas le besoin, satisfait qu'il était de la restitution archéologique ou de l'adaptation éclectique des formes traditionnelles.[449]

Viollet-le-Duc's Rationalist Theory of Architecture: From Structural Rationality to Subjective Reason

The debate concerning the church of Ste.-Eugene between Boileau and Viollet-le-Duc is usually considered a simple manifestation of the rigor of Viollet-le-Duc's rationalism over Boileau's eclecticism.[450] However, the debate in fact touched upon more subtle issues in architectural rationalism. While Viollet-le-Duc rightly pointed out the inconsistency of Boileau's rationalism by criticizing his church as a copy of the Gothic model in iron, he did not endorse the rational constructions of industrial buildings as proper architecture either. He considered iron halls such as exposition buildings and market halls as "industrial hangars," as he put it, differentiating them from architectural art.[451] Thus, after acknowledging the role of iron for the future in his critique of Boileau's church, he did not

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448 Louis-Auguste Boileau, Le Fer, principal élément constructif de la nouvelle architecture (Paris: by the author, 1871) p. 70
449 Foucart, op. cit., p. 64,
450 See, for example, Frances Steiner, French Iron Architecture and Foucart's article on Boileau as well.
451 For example, Viollet-le-Duc criticized les Halles as a hangar in Entretiens, vol. II, p. 42. Like other French architects, he also did not consider the Crystal Palace as architecture either, but a construction.

forget to add: " . . . mais n'oublions pas que ces édifices ne sont que des hangars d'une grande simplicité de plan, permettant l'adoption d'une forme unique que l'on répète indéfiniment. . . . Un système dont toute la solidité réside dans l'extrême précision des assemblages se rapproche plus de l'art du mécanicien que de l'art de l'architecte."[452] Consequently, Viollet-le-Duc put himself in the seemingly contradictory position of arguing for a rational and at the same time, monumental architectural art: How could architecture, while being a rational construction using modern material and construction technology such as iron, embody an artistic sentiment, and thus be differentiated from a mere industrial building? As already discussed in Reynaud and Daly's cases, the very impossibility of expressing a sentiment in a technological construction led the rationalists to accept the eclectic affirmation of duration of the taste of past styles. Boileau's unsuccessful attempt to create iron architecture also testified to the difficulty of the task. For that matter, Boileau was rather unambiguous since he finally admitted the secular characteristics of iron construction and produced his design of iron construction without pretension of creating a monumental style. Viollet-le-Duc, however, continued to carry with himself the ambitious, yet very difficult task of architectural rationalism to create a rational and yet, artistic form derived from the material and construction.

As we have discussed earlier, Viollet-le-Duc's rationalist theory of architecture was already present in his analysis of Gothic architecture in the Dictionnaire(1854-1868). However, more detailed discussions of art and architecture were developed in Entretiens sur l'Architecture (1864-72) which he prepared as lecture notes for his students since 1858, and whose first volume was published in 1864. Considering the theoretical task that Viollet-le-Duc faced, it should not be surprising that the first lecture of his Entretiens (1858) began with a definition of the concept of art. According to him, art is an instinct - a craving of the mind which, in order to express itself, employs various forms: " The arts

[452] Viollet-le-Duc, "A.M. Adolf Lance," Encyclopédie d'architecture, 1855, col. 83. "A system whose entire soundness lies in the utter precision of its assembling is closer to mechanical art, than to that of architects."

are. . . natural cravings, which, to obtain their satisfaction, assume a form subordinate to certain instincts of the soul- instincts which long observation converted into rules."[453] Forms are created first by imagination and then regulated by reason, while nature serves as an instrument. Artistic forms thus created, evoke emotion or impression in the souls of spectators through their senses. So, he argued that an architect who does not experience or evoke an emotion is a mere practitioner, not an artist. Viollet-le-Duc also emphasized the independent value of art. On the first page of the Entretiens, he argued that the development of good art and architecture has nothing to do with the degree of civilization of the society where it develops: "The value of Art is independent of the element in which it originates and flourishes."[454] Taking specific examples of modern iron buildings and modern eclecticism that he disliked, he explained that a more civilized State in other fields might be less advanced in art:

> If he [Augustus] visited our railway stations and most of our large establishments of public utility, would he not fancy us a nomadic people. Erecting our buildings in a slight and temporary fashion, with a view some day to their transport elsewhere? What would he say if he saw us constructing at the same time . . .some of them with pointed and others with flat roofs. . . Certainly Augustus would consider us a people devoid of any idea of Art. He would be wrong. But it is plain that Art is not dependent of civilization. [455]

Since art is based on imagination, not on facts, modern science could not denounce the artistic forms of the ancients as absurd. Thus, Viollet-le-Duc argued that art is independent from science as well. He even argued that "Art and the Knowledge of fact - Art and Science- may hold their course utterly apart."[456]

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[453] Eugène-Emmanuel Viollet-le-Duc, Entretiens sur l'architecture, vol. 1 (1858); translated as Lectures on Architecture, by Benjamin Bucknell (New York, Dover Publications, 1987) P.12
[454] Ibid., p.10
[455] Ibid., p. 15
[456] Ibid., p. 26

Viollet-le-Duc then set out to explain why it became difficult to create an art in modern society. According to him, feeling in primitive society was simple and thus, their artistic expression was homogeneously expressed in various artistic forms as in the processes in nature. In primitive simple society, thus, art flourished. By contrast, in modern society, artistic instinct was stifled by modern civilization; modern men use reason instead of acting intuitively. Moreover, in modern times, there were a multiplicity of notions and customs which belong to other periods. The complexity of ideas and feelings of the highly civilized modern society was thus difficult to express in homogenous artistic forms. "They, the barbarians," he wrote, "already created Arts. . . We came too late. . . We cannot reduce things to one homogenous system as they could. Our task as artists is a very difficult one. We retain a multiplicity of antiquated notions and customs which belong to a bygone civilization, together with the wants, customs and requirement of our time."[457]

Viollet-le-Duc's explanation, in a sense, accounted well for the failure of utopian positivism of the 1840s. As discussed in the previous chapter, it was the absence of collective ideas and feelings that rendered it fundamentally impossible to create a new architectural art with the products of modern science and industry. While other arts could retreat into their own spiritual world, matters were more complex in architecture; the seclusion from industrial everyday life and its vulgarity, and retreat into its own spiritual world were self contradictory if the creation of a modern architectural style required a rational use of modern materials and construction technology such as iron, as rationalists argued.[458]

At this point, Viollet-le-Duc found his answer in reason, or reasoning faculty of modern man as a mediating force. According to him, although the source of art is imagination, art is at the same time regulated by reason. Viollet-le-Duc wrote," we enjoy, like ancients, the power of reason, and to a certain extent that of feeling. And it is on these

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457 Ibid., p.29

458 However, it should be noted that the independent value of art and architecture that Viollet-le-Duc argued clearly echoed the contemporary bourgeois concept of art for art's sake, detached from modern industrial everyday life.

two faculties that we must rely our research after the true and the Beautiful."[459] He then brought up reason as a principal agency to create and appreciate art.[460] Although modern man might have lacked artistic intuition, faculty of reasoning could play a role to create art in modern society: "I was persuaded that the taste of the present generation might be improved by acquiring the habit of reasoning."[461] He even went as far as to argue that aesthetic judgment is nothing less than a process of reasoning: "Often-perhaps always - what we call taste is but an involuntary process of reasoning whose steps elude our observation."[462]

In modern society, therefore, Viollet-le-Duc argued in his sixth lecture (1860), it is in industrial products that style was maintained. He wrote: "At present day, style has quitted the arts and taken refuge amid industrial pursuits." He continued, "it [style] might be restored to the arts if we would introduce into our study and appreciation of them a little of that good sense which we apply to the practical affairs of life."[463] However, modern man, being unable to express their feelings, intent on imitating ancient arts. Viollet-le-Duc deplored this paradoxical nature of modern eclecticism:

> It would seem however that the more rationally we act with respect to the industrial arts, the further we go astray from reason when the fine arts are in question. We who in the construction of our machines give each of their component parts the requisite strength and shape, introducing nothing superfluous or which does not indicate a necessary function - in our architecture accumulate irrationally forms gathered from all quarters - the result of contradictory principles- and call this Art.[464]

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459 Viollet-le-Duc, ibid., p. 29

460 Summerson argued in his famous essay on Viollet-le-Duc that it was at this moment that modern architecture was born. However, as I will argue in this dissertation, it was a fiction. Reason was full of self contradiction and modern architecture was not derived from it. See Summerson, "Viollet-le-Duc and Rational Point of View," in Heavenly Mansions and other Essays on Architecture (London, 1948) pp. 135-58.

461 Viollet-le-Duc, ibid., p. 29

462 Ibid.

463 Ibid., p.187

464 Ibid.

Viollet-le-Duc argued that the eclecticism, which was made up of a confused mixture of the debris of an earlier civilization, lacked "style," the concept that he developed in the sixth lecture of the Entretiens.(1860) According to him, "style" resides solely in the true and marked expression of a principle and not in an immutable form."[465] For example, an ancient vessel and a modern locomotive have "style" because their forms indicated their purposes and they were fashioned in accordance with the material involved and the means of fabrication appropriate to them.[466] Likewise, architectural style has little to do with historical styles; it is to embody a specific structural principle, responding to the nature of the material, which was also a clear representation of the understanding of nature that an epoque gained, reflecting the degree of consciousness of the age. Therefore, if modern men copy Greek style, it does not have style; the moderns affected the original style that the ancients created by allying forms derived from traditions with modern requirements that were not in harmony with the traditions. Modern consciousness thus no longer invests faith in these forms.

Instead of copying past styles, therefore, Viollet-le-Duc argued, one should find the unchanging principle behind the creation of the styles. "Let us then strive to submit ourselves anew to those unchangeable principles; let us ascertain how our predecessors interpreted them in forms which were the real expression of the manners of the times; and we may freely pursue what is called the Path of Progress."[467] This could be done with "our reason as a guide, since this faculty at least remains to us amidst the chaos of modern times."[468] He wrote elsewhere: "Let architects learn to reason on what they are commissioned to do. . . and they will soon regain for art the ground it is daily losing."[469] Furthermore, architecture, along with music, is a non-representational art in which man's

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465 Ibid., p.181
466 See ibid., p. 184
467 Ibid., P. 33
468 Ibid.
469 Ibid., p.187

creative faculty develops itself most independently from imagination which uses forms in nature as an instrument: "It [Architecture] has not, in fact, to seek its inspiration in natural objects, but to follow laws laid down with a view to satisfy *certain requirements*."[470] These requirements were determined by materials, means of construction and programs, and the laws to satisfy these requirements were formed by nothing other than man's faculty of reasoning. Thus, Viollet-le-Duc developed a rationalist theory of architecture, purely depending on the rationality of construction and the faculty of reasoning: an appropriate use of material according to its natural properties and an honest expression of the structure, i.e., the correspondance between construction and decoration.

For Viollet-le-Duc, the prime example of this rational architecture was the Gothic. In the entry, "Construction"(1859) in Dictionnaire, he argued that Gothic construction provided an essential solution to the problem of forces in equilibrium: equilibrium of pressure and forces confronted in the space. The scientific notions of force and conservation of energy thus penetrated into the domain of art. He soon extended the scope of rational architecture to include classical architecture, arguing that the rational structural principles were found in all good architecture.[471] Then, it follows that one could also create a new style of modern, applying the rational principles to modern materials such as iron. Thus, it was not insignificant that Viollet-le-Duc ended his last lecture of the first volume of the Entretiens, entitled " Architecture in the Nineteenth Century - Importance of Method," with the Cartesian method of reasoning. He argued that, by the rational use of new materials, construction methods and programs, a new style of modern architecture could be created, just as the rational style of the Gothic was created out of the rational use of stone.

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[470] Ibid. my italic

[471] In the second volume of the Entretiens, Viollet-le-Duc included Greek architecture, as opposed to Roman architecture, in a reasoned architecture, where the honest expression of a structure and the appropriate use of a material based on its natural property were realized and above all, the decoration was a result of construction.

A significance of Viollet-le-Duc's rational theory was that rationality of the bourgeois humanist subject, rather that the rationality of construction, was introduced to architectural theory for the first time.[472] Obviously, this was an attempt to save the rationalist aganda in the fragmentation of art and technology, and subject and object. Whereas art for art's sake removed itself from anxiety and uncertainty of technological progress into its own spiritual domain, Viollet-le-Duc's rationalism resided in a belief in the rationality and spiritual progress of modern man. This belief in the rationality of the individual subject allowed him, without noticing its ultimate contradiction, to try to combine different materials such as iron, stone and bricks, while attempting at a rational, organic unity of the whole, as I will discuss later.[473]

Structural Rationalists' Vision of Iron Architecture and its Limitations

After almost completing the first volume of the Entretiens sur l'Architecture (1858-63), Viollet-le-Duc took up the idea implicit in the book that a complete reorganization of the teaching of architecture at the Ecole des Beaux-Arts was necessary in order to create a new style of art and architecture in modern society. In 1863, he proposed, with Comte de Nieuwerkerke and Comte de Laborde, a reform plan of the École des Beaux-Arts. Here, they opposed the specialization of painting, sculpture and architecture, claiming that the elimination of these distinctions could raise the aesthetic standard not only of industrial products to rival England, but also of the masses who utilize them. In short, it was an attempt to reunite art and everyday life, art and industry, and architecture and technology. They believed this would be possible by strong government intervention into the artistic institution which had been ruled by capitalistic markets and free competition, rather than by intrinsic truth or value. Their proposal was accepted by the government in the same year and the reform was underway. Among other measures implemented, a practical workshop

472 Here, a distinction should be made between Viollet-le-Duc's subjective reason and Laugier's novel savage.

473 I should be noted that other Gothic advocates such as John Ruskin, to the contrary, insisted on the exclusive use of organic materials such as brick and stone in architecture.

was established, where architectural material, techniques and construction were studied, and Viollet-le-Duc was appointed as Professor of theory.[474] However, the members of the Academy were furious. Conservative critics like Ingres strongly condemned the reform as a mixture of art and industry, and of *dessin* and *métier*. With the strong protest of the École students such as Guadet and Garnier, the reform finally failed, and only after seven lectures at the Ecole, Viollet-le-Duc resigned in 1864.

Although the reform of the Ecole failed, Viollet-le-Duc's structural rationalism became a mainstream of architectural rationalism during the 1860s. The application of modern material such as iron to architecture with a view to create a new style was naturally a major theme in architectural rationalism. Viollet-le-Duc was already interested in applying iron to modern architecture in the mid-1850s. The debate with Boileau in 1855 no doubt contributed to force him to consider the role of iron in modern architecture. In the entry "Construction" in Dictionnaire (1859), Viollet-le-Duc demonstrated as an example how iron could be used together with timber for the structural elements of a Gothic church, suggesting a possible use of iron in architecture.(fig. 98) However, the real question that he should answer was, as he himself had argued in the Entretiens, how to use iron rationally to create a new "style," not to replace elements of a past style.

In the early 1860s, iron was being widely used for architecture. Many iron public buildings such as Les Halles (1854-1866), the Gare du Nord (1861-1864), the church of St.-Augustin (1860-1872) and the Bibliothèque Nationale (-1868) were either built or under construction.(figs. 99, 100, 101) L.- A. Boileau continued to build his Gothic iron churches during the 1860s, translating the forms of the Gothic in iron, and Hector Horeau also proposed iron urban structures throughout the 1860s.(fig. 102) These applications of

474 See Anatole de Baudot, Réorganisation de l'École des Beaux-Arts, de son Influence sur l'Étude de l' Architecture (Paris, 1864). The 1863 decree consisted of the followings: the école was to be separated from the Academy; The Ministre de Beaux-art (Vaillant) was to be responsible for the appointment of the professors; The jury was to be nominated by the Conseil de l'École, twelve members designated by the Minister, and under the presidency of the Superintendent des Beaux-arts(Nieuwerkerke); The professors were not permitted to sit on the jury or on the Conseil de l'Ecole; New courses were to be introduced; The second Grand Prix was to be abolished and the first reduced from five to four years; The age of the candidates for the Grand Prix was reduced to 25 from 30.

iron to architecture raised heated debates among architectural critics during the 1860s. Conservative architects and critics were discomforted by the use of iron in public architecture. Alfred Darcel, reviewing the Salon of 1864 in the Gazette des Beaux-Arts, where projects of Boileau and Labrouste were exhibited, found the use of iron for architecture inappropriate. In his opinion, iron used in railway stations and market halls was unable to ensure monumental effects: ". . . les bandes et les tirants de fer qui forment les combles, ne possèdent point cet aspect monumental qui seul peut mériter le nom d'architecture à l'art qui les emploie."[475] In permanent buildings such as churches and concert halls, thus, it was masonry walls that dictated the forms. Even when iron was employed only in their roof structures, he argued these *"accessoires"* hardly constitute a style unlike rationalists' arguments. Thus, Darcel dismissed the iron roofs of Baltard's church of Ste.-Augustine and Labrouste's Bibliothèque Nationale as mere *"coûteuses fantaisies."*[476]

Ironical as it may seem, Viollet-le-Duc and the rationalists were also critical of the use of iron in these buildings. Their reason for criticizing the iron buildings was, however, quite contrary to that of academic architects; that is, they believed that in these buildings iron was not used rationally enough. In 1863, when Reynaud and Hittorff built the new Gare du Nord with a striking contrast between the stone facade and the iron interior hall (fig.84), Anatole de Baudot, a disciple of Viollet-le-Duc and a representative of the rationalist school in the 1860s, wrote a critical review of it based on their rationalist principles: "Ce qui nous frappe à première vue, c'est le manque de relation qui existe entre l'intérieur et l'extérieur de ce monument; évidemment ces deux parties n'ont pas été conçues dans le même esprit."[477] In the interior, material and functional needs were satisfied;" la force et la résistance des matériaux ont été calculées; il n'y a, pour soutenir

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475 Alfred Darcel, "La Peintre Vitrifiée et L'Architecture au Salon de 1864," in Gazette des Beaux-Arts (1864), P. 86.
476 Ibid.
477 Baudot, "La Nouvelle Gare du Nord, " Gazette des architectes et du bâtiment, no 14 (1863), p. 190

cette immense charpente, que le nombre de colonnes indispensable; chacun des membres de cette combination a sa raison d'être; rien n'est inutile; en un mot, l'œuvre est raisonnée; aussi le programme est-il rempli." However, in the facade, "ce ne sont plus le raisonnement et la nécessité qui commandent; ce n'est ni la nature des matériaux, ni la fonction qu'ils ont à remplir, . . tout est ici le résultat d'une fantaisie."[478] Viollet-le-Duc and the rationalists also distanced themselves from Boileau. While trying to ignore his activities, they distinguished their own brand of rationalism from Boileau's. In 1863, a year after Boileau was commissioned to build the cast iron church at Vésinet by winning the competition, they published a short but critical article in the Gazette des architectes et du bâtiment, a newly founded organ of rationalists' propaganda.[479]

Although the rationalists criticized the eclecticism of iron buildings, it was clear that they were not advocating industrial buildings either, as already discussed. However, despite their concerted effort to position themselves against both industrial buildings and eclecticism, Viollet-le-Duc and his school were accused by critics of advocating materialism and industrialism. In 1864, right after Viollet-le-Duc's resignation from his position as Professor of architectural theory at the Ecole des Beaux-Arts, which he held for less than a year, Bourgeois de Lagny wrote an article in L'Union des arts, criticizing Viollet-le-Duc and his school for favoring "*matérialisme dans l'art.*"[480] De Baudot immidiately responded in the same year GAB. He argued that by being faithful to material, needs and construction, their rationalism was advocating art, rather than "refusing" it. The problem, he maintained, was rather in the dogmatism of the Academy and the Ecole, which saw artistic principles only within the classical antiquity.[481] In an issue GAB of the same year, Viollet-le-Duc fils took up the Gare du Nord once again, this time, however, criticizing

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478 Ibid.

479 De Baudot, A., "Concours: Construction d'une Église au Vésinet," Gazette des architectes et du bâtiment (1863), p. 23

480 See Anatole de Baudot, "Réponse A L'Union des arts à propos de la démission de M. Viollet-le-Duc" Gazette des architectes et du bâtiment (1864), p. 97-98

481 Ibid., p. 97

even its interior iron hall as lacking art. This change of position on the iron hall of the Gare du Nord was perhaps a conscious effort to guard against the accusation of materialism. He wrote:

> L'emploi de la fonte, tel qu'il a été traité pour couvrir le vaisseau de la gare proprement dite, fait honneur au constructeur, en tant qu'il s'agit de l'application raisonnée des aptitudes de résistance de cette matière, mais on ne voit pas encore intervenir là les efforts de l'artiste pour rehausser et caractériser ces aptitudes par des formes particulières. Les profils et les ornements qui décorent les colonnes de fonte procèdent bien plus d'une interprétation de formes convenant à la pierre que de l'observation des propriétés de la matière mise en œuvre. Si les architectes ne peuvent encore peser de leur autorité d'artistes sur ce produit de l'industrie moderne, c'est surtout parce qu'ils reculent devant l'étudie des principes qui règlent les conditions de son application. Lorsqu'ils seront maîtres de la théorie, ils aborderont la pratique avec plus d'audace, et n'hésiteront plus à rechercher une décoration en harmonie avec cette matière. Jusque-là le fer restera rebelle à l'originalité de nos artistes, et les constructions en fonte n'auront d'autre caractère que celui des œuvres du commerce.
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> La nouvelle gare du Nord est peut-être l'erreur la plus grossière.[482]

However, while criticizing the iron buildings for not being rational enough and for adopting past styles, whether Classic or the Gothic, Viollet-le-Duc and the rationalists did not provide a solution to the problem of iron architecture either. Viollet-le-Duc did not even use iron in his buildings during the 1860s except for simple trusses for the sacristy of the Cathedral of Reims and the Château of Pierrefonds (both designed in 1862), nor did his disciple de Baudot dare to use iron in his churches until 1865. Instead, the rationalists tried to make their case through critiques of other iron buildings.[483]

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482 E. Viollet-le-Duc fils, "La Nouvelle Gare du Nord," Gazette des architectes et du bâtiment (1864), p.33

483 The only building of which they seemed favorable was Labrouste's Bibliothèque Nationale. In the 1865 GAB, de Baudot wrote a sympathetic article to the Bibliothèque Nationale.

Amid polemics, Viollet-le-Duc restrained himself from a direct response to criticism and continued to write chapters in the second volume of the Entretiens, which were, however, extremely important ones. In the first four lectures of the second volume, written between 1863 and 1866, Viollet-le-Duc explored extensively the possibility of using iron in architecture. Here, he made his position against industrial buildings even clearer. He even withdrew his earlier favorable appraisal of the Les Halles, writing, " . . .buildings that are entirely of iron, such as the *Halles Centrale* of Paris, and some great railway stations, . . which though well designed are after all only sheds."[484]

Viollet-le-Duc believed that the use of masonry structures for architecture was inevitable because only masonry walls could provide the protection against dampness or extreme heat. He wrote:". . . it must be admitted that buildings erected entirely of masonry, that is, with slight stone or brick-work vaulting, and walls of sufficient thickness to serve as a protection against damp or extreme heat, affords, in many cases, advantages which nothing can compensate."[485] However, as he argued, traditional masonry architecture lacked the capacity to meet modern needs such as gathering of large public in a comfortable and well-lighted place. He then suggested that the mixed use of masonry and iron could solve the dilemma between architecture and industrial sheds, taking only their merits. He asked rhetorically: "But there is nothing intermediate between a vaulted block of stone, like the Madeleine, and a railway station? Are we condemned to have for our public buildings only hypogea or sheds? And for our palaces is there no medium between casinos of trumpery iron work, lath and plaster, and the Versailles or the Louvre?"[486] A simultaneous use of masonry and iron, for Viollet-le-Duc, also could guarantee the monumental and artistic character of iron architecture. He believed that engineers, though they were promoters of the new construction system[i.e., iron structure], lacked knowledge in artistic form. "They [engineers] have employed iron merely in view of

[484]Viollet-le-Duc, Entretiens sur l'Architecture, vol. II. Translated as Lectures on Architecture vol. 2, by Benjamin Bucknell, p. 44
[485] Ibid., p. 45
[486] Ibid.

practical utility without regard for artistic form."[487] The artistic form no doubt could be achieved by architects who had direct influence on masonry structure with experience and artistic senses, not with calculation.

In simultaneously using masonry and iron, Viollet-le-Duc insisted on the complete separation of the materials as Reynaud had argued several years earlier in his Traité d'Architecture. Otherwise, the materials would diminish each other's strength by a different ratio of contraction. However, iron should not merely replace structural elements of masonry, but should be employed according to its material properties and structural logic. Only through the rational use of material and the mode of construction, he argued, would a new rational form result. He also maintained that iron should remain visible in order to make its repair easier. Judging from these points of view, Viollet-le-Duc found contemporary iron buildings not satisfactory: "As regards the mixed method, consisting in a simultaneous employment of masonry and iron in the same building, it has hitherto been attempted only in a timid way, and it must be confessed, with unsatisfactory results."[488]

In an Atlas published in 1864, Viollet-le-Duc proposed several designs of iron architecture, such as a hall for 3000 and a covered iron shop. (figs. 103, 104) In his exemplary designs, Viollet-le-Duc attempted to use iron in the structural system according to its properties and the structural logic. For example, he claimed that his designs replaced "an agglomeration of passive forces" of masonry structure with "the distribution of active forces" of iron structure.[489] In this respect, he argued, medieval architecture was helpful as an example since it satisfied the laws of equilibration and elasticity. However, it is obvious that his designs were basically a Gothic model as many critics pointed out.[490] His

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487 Ibid., p. 71
488 Ibid., p. 44
489 Ibid., p. 68
490 It was Charles Garnier who first pointed it out in A Travers les Arts (1869). A modern historian, John Summerson held the same opinion. See "Viollet-le-Duc and Rational Point of View," in Heavenly Mansions and other Essays on Architecture (London, 1948) pp. 135-58. Also Robin Middleton, "Chapter 10, The Entretiens sur l'Architecture," volume II, in Viollet-le-Duc and the Rational Gothic Tradition (Ph.D. dissertation, Cambridge University, 1958)

designs were not even a representation of a rational use of material, or of a rational structural system. The simultaneous use of masonry and iron was itself inconsistent in terms of structural static. Therefore, it was not totally without grounds that Viollet-le-Duc's designs were criticized by academic architect as a Gothic translated into iron. In his review of the 1866 Salon in Moniteur des Architectes, Bourgeois de Lagny criticized L.-A. Boileau's design of an iron church for appropriating Gothic form, recalling the attack that Viollet-le-Duc had mounted on Boileau in 1855.[491] Then, he chastised Viollet-le-Duc for falling into the same mistake:

> Comment après cela, M. Viollet-le-Duc est-il tombé lui-même dans cet mépris, dans un ouvrage en cours de publication, qui pourrait être si utile! qu'il pouvait si bien faire! Si cet ouvrage n'eût été dès le commencement entaché d'un esprit de système et d'innovation en matière d'art et de formes artistiques, qui n'est point, et ne peut-être, comme je l'ai dit, dans le caractère de notre époque?[492]

In 1865 de Baudot, probably influenced by Viollet-le-Duc's ideas, attempted for the first time to incorporate columns of iron along the nave in the design competition for the church at Rambouillet. He set these columns two feet in front of light piers of stone; together they served to support the stone vaults of the nave and aisles. This system was intended to preclude the use of flying butresses while retaining an air of light internal structure. De Baudot tried to differentiate his design from Boileau's entry for the competition, which also used iron structure. In 1866 he wrote about Boileau's design: "Le parti général adopé par l'architecte n'est pas un système, mais simplement l'application du métal à des formes qui ne résultent pas des propriétes des matériaux employés."[493] De

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[491]" Il prétend tout simplement approprier des formes connues, des formes en rapport avec les matériaux employés dans les constructions du moyen âge (les nervures en pierre du petit appareil, les arcs en ogive), il prétend tout simplement approprier ces formes à des matériaux tout différents, à des matérieux comme la fonte et le fer." Bougeois de Larny, "Salon de 1866, Architecture," Moniteur des Architectes, vol.1 (1866) p. 115.

[492] Ibid.

[493] Anatole de Baudot, Gazette des architectes et du bâtiment, no.7 (1866) p. 97

Baudot fashioned his design as a more rational and more appropriate use of iron than Boileau's. However, his design was neither an entirely rational use of iron, nor a new rational form. As César Daly criticized thirteen years later, de Baudot's church was an "awkward compromise between Gothic revivalism and modernism."[494] Bourgeois de Lagny also ridiculed de Baudot's design as a naive paraphrase of the Gothic.[495]

The inability of Viollet-le-Duc and his followers to give form, a vital visual expression, to their rationalist ideas, was not due to their lack of talent in design, nor to their being "designers of small caliber," as most historians believed.[496] Rather, their incapability was a result of fundamental ambiguities and contradictions in the principles of rationalism. First of all, Viollet-le-Duc's concept of reason as an active agent to create rational and yet monumental architecture was problematic. A fundamental question here was the relationship between "reason" and "scientific or technological rationality." As already discussed, although Viollet-le-Duc occasionally admired the rationality of industrial products such as the steam engine,[497] he clearly distinguished between rationality in the industrial process and the "reason" in the production of art: While "technological rationality" was a process independent of human intervention, and thus, non-artistic, "reason" is a God-given faculty of men. He wrote: "We are master of our reason. . , we are able to make out of it an attentive "operator" for ourselves, able to regulate our actions and ensure that our accomplishments are both lively and lasting. . . . Style originates, therefore, in an intervention of *reason.*" [498] However, Viollet-le-Duc was not consistent

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494 César Daly, RGA (1879) p. 20.
495 See, Bourgeois de Larny, "Salon de 1866," Moniteur des Architectes. vol.1 (1866), p. 84
496 e.g., see John Summerson, "Viollet-le-Duc and Rational Point of View," in Heavenly Mansions and other Essays on Architecture (New York: Norton, 1963) pp. 135-158. Also Robin Middleton, "Chapter 9, The Ecole des Beaux-Arts and the Ecole Viollet-le-Duc," in Viollet-le-Duc and the Rational Gothic Tradition (Ph.D. dissertation, Cambridge University, 1958), note 171.
497 See Viollet-le-Duc, Entretiens, translated by Benjamin Bucknell, vol. 1, p. 184
498 Viollet-le-Duc, E.-E, "Style," Dictionnaire raisonné de l'architecture française du XIe au XVIe siècle, 10 vols. Paris, 1854-68. Translated by Kenneth D. Whitehead in The Foundations of Architecture, p. 240-2. My italic

in his use of the concept. In many parts of his writing, he used reason and scientific rationality interchangeably. This ambiguity of Viollet-le-Duc's concept of rationality was most clearly demonstrated when he explained the aesthetics of rational architecture. For example, he maintained that architecture is beautiful when its load bearing system is honestly expressed through its form: "Quand, de sentiment, ou par une méthode purememt empirique, une forme architecturale satisfait les yeux ou l'esprit, on peut être assuré que le calcul démontre que cette forme est celle qui est commandée par les lois de la science."[499] It was also on this ground that Viollet-le-Duc argued decoration should be the result of construction.

Viollet-le-Duc's confusion of "reason" and "technological rationality" was, in fact, not at all unexpected, given the intrinsic relationship between them; modern technology itself is human reason's domination over nature. Viollet-le-Duc himself admitted this when he argued that, in modern society, the human mind did not act in the same way as in nature, but proceeded with reasoning as in industrial products; modern technology was then a kind of second nature in which modern men operated, and this was in fact why he introduced "reason" as an appropriate means to approach artistic production and reception in modern society. However, as modern technology developed, it gradually became an autonomous processes of itself, eliminating the room for individual subjective reason to intervene. Max Horkheimer succinctly put this dialectic nature of the development of modern technology: "Technology is the extension of the subject, but it is necessarily also a movement away from the subject."[500] In this process, thus, there came to be a separation between subjective reason and technological rationality, and between architectural art and industrial buildings. I have already discussed this dialectical aspect of modern science and technology in the paradoxical nature of and final collapse of Neoclassicism in the first part of this dissertation. The subsequent categorical separation between art and technology was

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499 Ibid.
500 This dialectical process of modern technology was a major theme of the Frankfurt School's analysis of modern culture. See, for example, Max Horkheimer and Theodor W. Adorno, Dialectic of Enlightenment, (New York: Continuum, 1969)

a consequence of the alienation of the subject from the modern scientific and technological rationality.

In fact, what Viollet-le-Duc's rational theory of architecture was after was to bridge the gap between art and industry, of subjective reason and objective technology; but he tried to do so by simply reclaiming the authority of the rationality of bourgeois subjectivity. He believed that "reason" could create a rational, yet artistic form of architecture which was distinguished from mere industrial buildings. However, as discussed earlier, the rationality of an individual subject, capable of intervening and controlling the technological processes of production, was already obsolete in the modern technological society; modern technological rationality, like structural static, operated with its own logic, saparate from subjective reason. Scientific rationality, or structural static, however, cannot create an aesthetic criteria on its own, unless one make an ethical postulate of logically consistent load bearing behavior of the structural system.[501] This means that one has to choose scientific rationality, rather than subjective reason, as the ultimate agency for art and thus, to accept industrial buildings as architectural art. Viollet-le-Duc was reluctant to accept this and based his rational architecture instead on a historical reference--the Gothic or the Byzantine, as his designs proved. He himself wrote in his lecture: "For us architects of the nineteenth century-and this can not be too often repeated-originality can result only from the adoption of appliances hitherto unused with forms previously invented, though without contravening those appliances."[502]

Viollet-le-Duc and the rationalists seemed to have already sensed the difficulty of their tasks. Contrary to their words, they were unsure as to the future of their architecture. After the church at Rambouillet (1865-1868), de Baudot did not use iron for his churches and basically remained in the secure Gothic revivalism. In 1866 he also wrote an article in the GAB, justifying the fact that Viollet-le-Duc did not use iron in the church of Ste.

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501 For an excellent critique of so-called constructivist aesthetics, see Stefan Polónyi, "The Concept of Science, Structural design, Architecture," in Daidalos (Dec. 1985) pp. 33-45
502 Viollet-le-Duc, Entretiens, vol. 2, trans. by Benjamin Bucknell, P. 73

Denis.[503] However, their belief in reason and its ability to create a new style did not fade away. In 1866, in the midst of the polemics, Viollet-le-Duc wrote the entry, "Style," in the Dictionnaire, which is considered by many scholars to be the quintessence of his rationalist thought. Here, he defended his structural rationalism based on reason once again. However, this time, he was clearly on the defensive. He himself admitted the legitimacy of the question raised against him, noting: "No, it [iron architecture] is nothing but science, ingenuity, some will object; it is not art at all. . . They are no doubt entitled to their opinion."[504] But he countered that even rational forms of industrial constructions were not completely devoid of ideas and sentiments. He wrote: "We can admit that the presence of all these material facts in no way constitutes an art. But is that the end of it? Would constructions fashioned along these lines be devoid also of ideas? And would theses ideas be impenetrable and mysterious for all of us who are their children."[505]

In fact, in this article, Viollet-le-Duc slightly revised his earlier theory of style discussed in the sixth lecture of the Entretiens. Style, in his entry to the Dictionnaire, was presented as an abstract principle in nature, manifested in a geometrical principle of triangles in natural forms.(fig. 105) It is an automatic result of the rational process of creation in nature, the making manifest of universal principles in the logical solution to a problem of form. Thus, came his famous definition of style: "*style is the manifestation of an ideal based on a principle*" and "*Style belongs to mankind; it is independent of the objects.*"[506] Consequently, in attempting to bridge the gap between art and technology, in protest against the fragmented bourgeois culture, Viollet-le-Duc linked reason back to the principles of making in nature, rather than to technological process. However, this was done at the expense of the abstraction and subjectivization of architectural form. Objective structural rationality of "Style" that Viollet-le-Duc advocated, thus, became an abstracted

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503 De Baudot, "Eglise Paroissiale de Saint-Denis," GAB (1866) pp. 113-114
504 Viollet-le-Duc, "Style," Dictionnaire, trans. by Kenneth D. Whitehead, p. 260
505 Ibid.
506 Ibid., p. 233

and subjectivized principle of architectural form: an obvious representation of alienation of the subject from the technological reality. An architectural historian, David Van Zanten described Viollet-le-Duc's abstract theory of architecture rather plainly:

> Viollet-le-Duc's analogy of architecture and geology made one specific point: that his was, in a sense, a Copernican point of view. In the period from Boullée to Vaudoyer, a building had been conceived in terms of its *marche* - like the medieval universe, from the standpoint of the human occupant. In Viollet-le-Duc's epoch, it was conceived abstractly, from everywhere and nowhere at once - like the earth itself in Copernican astronomy, as an abstract diagram of natural forces. . . Viollet-le-Duc's "salle voûtée," . . , assumed a sense of abstraction and extra human perspective in order to comprehensible.[507]

However, I believe that Viollet-le-Duc's abstract theory of style had much more significance in the history of modern architecture than this simple description conveys. It was clearly a logical consequence of rationalist theory based on reason. His abstraction of architectural forms prefigured the abstract theory of modernism that fundamentally differentiates it from traditional art and architecture based on representation. Through the abstraction and the subjectivization of architecture, Viollet-le-Duc's theory, along with modernist arts, was paradoxically in what Adorno called "mimetic relation" with the fragmented and alienated bourgeois society.[508]

Critics of Structural Rationalism and Their Alternatives

After the failure of the reform of the Ecole, Viollet-le-Duc and the rationalist architects founded *École Centrale d'Architecture* in 1865, with Émile Trélat, an architect and Professor of construction at the *Conservatoire des Arts et Métiers* to carry out their

507 David Van Zanten, "Architectural Composition at the Ecole des Beaux-Arts from Charles Percier to Charles Garnier," in The Architecture of the Ecole des Beaux-Arts (New York: MOMA, 1983) pp. 218-219
508 See Theodor Adorno, Aesthetic Theory (New York & London: RKP, 1984) pp. 79-84

rationalist program. As Trélat wrote in the 1864 prospectus, the purpose of the school was to educate architects about the unity of science and art, and of technology and architecture.[509] They believed that architects' social position, which they thought was on the verge of extinction because of engineers, could also be regained only through an efficient technical training of the architects.

When the École Centrale was established, however, César Daly criticized the school, accusing it of teaching mere construction without art.[510] Daly was a strong advocate of technological discourse in architecture during the 1840s, who argued for a more technical education in architectural schools. However, with disenchantment with the utopian positivist belief in the unity of science and art, Daly was convinced that rationalism in the context of the separation of art and science, could not satisfy aesthetic desire of the society, and gave up his positivistic rationalism. He wrote: "L'Ecole rationaliste prend une importance considérable parmi nous; c'est une école très propre à assurer les progrès techniques de l'architecture, mais très propre aussi à attarder ses progrès esthétiques."[511] Thus, when Viollet-le-Duc sought to find a new style of modern architecture by relying upon reason and the rationalist principles, Daly naturally criticized his quest as an endorsement of industrial architecture which lacked *sentiment* and art.[512] "L'école rationaliste [the Ecole Centrale], qui tend en ce moment à transformer l'art architectural en architecture industrielle, proclame ainsi devant tous son scepticisme en matière d'art, son

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509 See Viollet-le-Duc, Lettres Inédites (Paris, 1902) p. 45

510 See Daly, "Introduction," RGA (1866), col. 1-10

511 Daly, "Introduction," RGA (1866), col. 3

512 In 1862 Daly directly refuted the rationalist argument for an appropriate form for every material. See Daly, "Ferronnerie de la Renaissance," RGA (1862), col. 258: "C'est qu'il n'est pas historiquement exact de dire qu'à toutes les époque où l'art a brillé avec éclat, la nature de la matière a toujours déterminé exclusivement, et en dehors de toute autre considération, les formes de l'architecture." For the debates between Daly (RGA) and Viollet-le-Duc's school (GAB), see "A Propos de M. Viollet-le-Duc et des réfomes à l'Ecole des Beaux-Arts," RGA (1864), cols.129ff. Daly wrote a critique on Viollet-le-Duc's rationalist school and offered his own definition of rationalism in " Ce que peut raconter une grille de fer de l'influence des fermes sur l'architecture au XVIIIe siècle," RGA (1864), p. 86.

respect exclusif pour la science et l'utile."[513] Daly warned that, at the rationalists' creation of the Ecole Centrale, engineers would dominate architects, rather than the vice versa:

> *L'Ecole rationaliste* vient proclamer que c'est la Raison - qui n'a jamais créé une œuvre d'*art* depuis l'origine des temps - qu'il faut constituer seul juge,((*le premier et le dernier juge*)) des œuvres d'architecture, sans se douter apparemment qu'en dépouillant l'architecture de toute poésie, elle ne laisse debout qu'une *industrie du bâtiment,* et supprimer, par voie de conséquence, comme une simple doublure des ingénieurs civils, le corps entier des architectes, . .[514]

Daly's concern seemed soon to become apparent. By 1868, despite the protest of Viollet-le-Duc and de Baudot, Trélat and the Ecole Centrale moved away from the strict rationalism and drifted into Symbolism.[515] Thus, Daly's criticism of the rationalist school was proved legitimate. In the categorical separation of art and industry, providing architects with more engineering education would simply mean the production of second class engineers, or as Daly put it, of "doublure des ingénieurs civils." The change of the École Centrale must have been an inevitable consequence of the rationalists' attempt to salvage architects' role from mere industrialism, which prefigured Art Nouveau two decades later.[516] The change of the École Centrale made it clear once again that the separation of art and technology could not be overcome either by simply reconstituting reason, or by teaching more science and technology to architects.

Daly's alternative way out of this dilemma of rationalism was, as I already mentioned, to pursue formal aesthetics, rather than a rational construction. For Daly, a

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513 Ibid., col. 5
514 Ibid., col. 8
515 Regarding the change of the Ecole Centrale, see Robin Middleton, "Viollet-le-Duc' Academic Ventures and the *Entretiens sur l'architecture,*" in Gottfried Semper und die Mitte des 19. Jahrhunderts, ed. by A.M. Vogt, C. Rebel and M. Fröhlich (Basle, 1976) p. 253. De Baudot and Viollet-le-Duc protested against the school's tendency toward Symbolism, and finally detached themselves from the school.
516 It is interesting to note in this respect that Viollet-le-Duc's own design of iron architecture was considered later a precursor of Art Nouveau decoration.

solution to the contradiction of bourgeois culture caused by the separation of art and science no longer lay in the invention of a rational construction, but in the creation of a new artistic form corresponding to modern science and industry. Unlike structural rationalists, Daly believed that the forms were to be created first, rather than a result of construction. "Ce n'est jamais la raison qui a créé une oeuvre d'art depuis longtemps."[517] Thus, it was on the aesthetic forms that architects should concentrate, which was, in fact, what distinguished them from engineers; engineers were a specialist of the economy of structure, whereas architects, that of forms and aesthetics.

Already in 1853, as discussed earlier, Daly began to propose a systematic eclecticism as an attempt to reconcile art and science and thus, to create a new style for the future, which he called organic. Daly 's research for a new organic architecture was distinguished from both the rationalism of Viollet-le-Duc's school and the eclecticism of the Ecole des Beaux-Arts. Daly first proclaimed an Organic school of architecture in 1863, distinguishing three French schools at work: Historic, Eclectic and Organic.[518] He was confident that the new architecture would be born from the *école organique*, or as he said, *l'école de l'Avenir* which was then emerging.[519] In 1866, Daly defined three schools, *école classique, école neo-gothique and école-rationaliste*, the first two constituting *école historique*.[520] The historical schools became purely eclectic while rationalist school represented aesthetic skepticism. While the classical school misunderstood the role of modern science and industry, the rationalists disregarded poetic sentiment. Opposing both eclectic historicism and rationalism, Daly then proposed systematic eclecticism as a road toward the new organic art.

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517 Daly, RGA (1866), col. 8

518 Daly, "Introduction" and "Ma nouvelle publication," RGA (1863), cols. 163 ff.

519 Ibid., col. 164. He defined Ecole Organique in this way: "Par contre, l'école organique suppose la plus énergique aspiration vers un idéal nouveau, une interprétation philosophique du Passé en vue de le dominer profit du Présent et surtout de l'Avenir. . . . Nous l'avons ainsi nommée parce qu'elle est, par rapport aux écoles *historique* et *éclectique*, ce qu'est la *vie organisée*, végétable et animale, par rapport à l'*existence inorganisée* des roches qui forment le substratum du monde; parce qu'elle doit éclore et se développer à la facon des *germes vivants*, et non pas se constituer comme les minéraux par voie de *juxtaposition d'éléments inertes*."

520 Daly, "Introduction," RGA (1866), cols. 1-10

What Daly attempted to do was to find the middle ground between reason and sentiment. As he epitomized in the 1868 RGA, "[L]a doctrine sans critique appliqué, c'est la science abstraite, c'est l'absence de vie. La critique sans doctrine, c'est la fantaisie individuelle et d'un moment substituée à la loi de l'éternité et de l'humanité. Nous voulons la vérité et la vie, la science et l'action, la théorie et la pratique"[521] It seems a logical process then that Daly found an answer in a new geometrical form, such as an elliptic line, which could be related to modern science and industry. Daly developed a systematic theory of eclecticism in his "De l'architecture de l'avenir" of 1869 in the RGA. He sought to find structural lines in concert with universal vocabulary of lines of composition and massing, which become a symbolic expression of a period. As columns and lintels were the motifs of Greek architecture, as arches were that of Roman architecture, and the pointed arch, that of Gothic architecture, the ellipse was that of Daly's organic art of modern period.(fig. 106) Daly believed that the new forms would be created by elite artists and architects who were endowed with a special quality and artistic genius. In this way, he separated elite high architects with artistic sentiment from mass architects for utilitarian buildings, and architectural monuments and industrial buildings: Quatremère de Quincy's thesis three decades earlier. In industrial buildings, Daly admired its industrial character while in monumental architecture, he emphasized formal aesthetics.[522] The aesthetic rationalism, argued by Daly and Trélat, though a bit differently, became a major theme of architectural rationalism in the 1870s and 80s, which I will discuss in the next chapter.

Another leading critic of structural rationalism and its theory of iron architecture during the 1860s was Charles Garnier, one time a draftsman of Viollet-le-Duc and the architect of the Paris Opera. Although Garnier was a student during hectic days of Gothic rationalism, and

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521 Daly, RGA (1866), col. 10. For a detailed study of Daly's theory of modern architecture, refer to R. J. Becherer, Science and Sentiment: César Daly's Formula for Modern Architecture (Ann Arbor: UMI Press, 1984) Especially Chapter 3. "César Daly's Architectural Theory."
522 This was why Daly admired Les Halles, while criticizing the church of Ste.-Eugène. See Daly, " Nouvelles et faits divers," RGA (1857) cols. 100-104.

learned drawing under Viollet-le-Duc at the *Ecole de Dessin*, he rejected Viollet-le-Duc's rationalism. As a student of Lebas and the winner of the 1848 Prix de Rome, Garnier's concept of art was formal aesthetics based on classical tradition. Thus, like other academic architects, Garnier was critical of the use of iron in monumental architecture, largely because of iron's lack of a visual property of solidity. In 1857, Garnier wrote in Musée des Sciences:

> The impression one should feel at the sight of a monument is the sentiment of grandeur, of nobility, of calm, and of confidence. . . .
>
> The means one should employ to give architecture this character of nobility and security all derived from the same principle, specifically the harmony of the proportions and the relationships in general between the masses and the voids. What is more opposed to these requirements than construction in iron? In fact, in this genre of construction, the supports are thin, elongated, and of less importance than the parts they support.
>
> It is thus the inability of iron to provide masses and supports satisfying to the eye which necessitates its rejection for any artistic construction.[523]

However, Garnier did not reject the use of iron for architecture altogether. What he criticized was Viollet-le-Duc and the rationalists' attempt to reconcile art and industry.[524] He wrote: "Truth is not beauty. They are two. Poetry and Progress are two ambitious men who hate each other."[525] For Garnier, their attempt to use iron in monumental architecture was to confuse art and industry; art belongs to intuition and industry to reason, and each had its own purposes. Therefore, the use of iron, he argued, should be limited to utilitarian buildings such as market halls and railway stations. Garnier continued writing, likening iron to photography:

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523 Charles Garnier, "L'Architecture en fer," Le Musée des Sciences 41 (Feb. 11, 1857) pp. 321-323, translated in Van Zanten, Designing Paris (Cambridge: MIT Press, 1987) p. 239.
524 In this sense, Garnier also criticized Daly.
525 Charles Garnier, op. cit., Translated in Henri Loyrette, Gustave Eiffel (New York: Rizzoli, 1985) pp. 171-172.

> When any invention comes to reveal hitherto unknown material and processes, it often happens that, through a desire to give them too wide a scope and to multiply their various applications, the limit which ought to be assigned to them are overstepped and a useful and advantageous system is replaced by one which is merely more or less ingenious. In this way photography , otherwise destined to offer valuable service, comes every time to try to replace art with science, feeling with precision; in this way, iron, whose use is greatly to be preferred to that of wood in almost all areas of construction, comes to encroach upon architecture, to change its characteristic forms and finally substitute industry for art.[526].

It should be noted that by formal aesthetics of architecture, however, Garnier did not simply mean a copy of past styles. Like Viollet-le-Duc, he also advocated the creation of a new modern style. As Robin Middleton pointed out, Garnier was in fact doing with Greek and Roman architecture what Viollet-le-Duc wished to achieve through the Gothic -- "to transfuse past styles, intellectually, into contemporary design."[527] He wrote: "Si nous étudions le grec, si nous étudions les monuments de l'antiquité, nous ne les copions pas; nous y cherchons des préceptes et des exemples, mais nous cherchons aussi en nous un sentiment et une volonté. Nous regardons, mais nous créons."[528]

The most conspicuous difference between them was that whereas Viollet-le-Duc considered reason as the agency to deduce and apply the unchangeable principles of architecture, Garnier believed intuition and sentiments, rather than reason, to be the primary agency for the application of classical principles. According to Garnier, reason is significant only after intuition has established a general framework: a direct refutation of Viollet-le-Duc's theory that style is "unconscious reason" and "la manifestation d'un idéal établi sur un principe." Garnier wrote in Le Théâtre (1871):

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526 Ibid.

527 See Robin Middleton, Viollet-le-Duc and the Rational Gothic Tradition (Ph.D. Dissertation, Cambridge University, 1958)

528 Cited in Louis Hautecœur, Histoire de l'architecture classique en France, vol. 7 (Paris, 1957), p. 180.

Le raisonment a priori est donc inutile, puis qu'il se produit inconsciemment. Il serait nuisible s'il voulait remplacer le sentiment et prendre la première place au détriment de la main qui opère et les yeux qui jugent. C'est pour ce là que je repousse instinctivement et volontairement l'école utilitaire qui. . . part du raisonment seul et . . . tombe à tout instant dans le faux et produit sous le précieux prétexte de logique.[529]

If one admits that architectural style is more than a mere consistent expression of the scientific rationality of a structure and that reason alone could not create a style without formal references, Garnier's theory was certainly more consistent and realistic than Viollet-le-Duc's. Garnier already made his case clear in A Travers les Arts, Causeries et Mélanges, published in 1869 as a direct response to Viollet-le-Duc's Entretiens. Here, Garnier pointed out, very perceptively, the fact that historically, traditional forms of architecture continued to be used regardless of the introduction of new materials and technology and thus, material and technological progresses had little to do with advances in architectural design:

Que les constructions soient en pierre, en marbre, en fer ou en bois, elles procèdent et procèderont toujours du type architectural alors en vigueur. Les maisons en bois de la Renaissance ont le même style que les maisons en pierre du même temps, et les ouvrages de ferronnerie qui nous sont conservés indiquent nettement l'époque à laquelle ils ont été façonnés. Viennent des matériaux nouveaux, l'art les emploiera suivant leurs convenances; mais il se les assimilera et leur donnera les formes caractéristiques qu'il manifeste.[530]

Thus, Garnier criticized rationalists and engineers' tendency to use iron to create a new style of modern architecture. He wrote: "...on n'est pas éloigné de croire que c'est

529 Garnier, Le Théâtre (Paris, 1871) p. 414.
530 Garnier, À Travers les Arts, Causeries et Mélanges, (Paris, 1869) Reproduced with François Loyer's introduction (Paris: Picard Éditeur, 1985) p.95

parmi les constructions des ingénieurs que se dégagera la solution. Ceux-ci ont en effet de fréquentes occasions d'employer le fer en grandes parties, et c'est sur cette manière que plus d'un fonde l'espoir d'une architecture nouvelle."[531] But he declared: "Je le dis tout de suite, c'est là une erreur et une grande erreur; le fer est un moyen, ce ne sera jamais un principe." [532] If iron public buildings such as market halls and railway stations had different aspects from stone constructions, those aspects were derived from the functional characteristics of the buildings, not from their use of iron; they themselves, he argued, did not constitute a particular style of architecture. He continued:

> Le Palais du Champs de Mars, qui ne ressemble guère à l'École Militaire, sa voisine, n'est pas pour cela de l'architecture nouvelle; c'est un abri plus ou moins gigantesque, mais ce n'est qu'un abri dont le principe se retrouve dans les volières et les serres, connues dès la plus haute antiquité. C'est l'indication de l'usage du fer, mais c'est aussi l'indication de son impuissance du fer à réaliser lui-même une révolution artistique. Le hangar: voilà la destination du métal; la diminution extrême du point d'appui et l'augmentation des portées: voilà la mission de l'architecture métallique.[533]

Garnier then recommended the limited use of iron for buildings, such as canopies, where its properties could well be expressed. Like Viollet-le-Duc, he believed that solid masonry walls were "les données premières et impérieuses" of architectural art. "Si, comme construction proprement dite, le fer a des ressources innombrables et se prête à des hardiesses inconnues." However, "comme art, il n'a pour ainsi dire pour avenir que le point d'appui et la couverture."[534] Thus, he justified the practical use of iron for interior structures of buildings only if their exterior were encased with stone. As examples where iron was used judiciously and artistically, Garnier took Baltard's Les Halles, Hittorff's Gare du Nord and Labrouste's Bibliothèque Sainte-Geneviève. "Dans ces constructions,"

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531 Ibid., p. 95
532 Ibid.
533 Ibid.
534 Ibid., p. 96

he wrote, "le sentiment personnel des artistes se fait sentir; c'est une expression particulière du style actuel qui s'est imposée à la matière. Le fer remplit les exigences de la construction mais il porte dans ses détails la marque typique de l'architecture de notre époque; il ne l'a pas modifiée, mais il s'est modifié pour elle."[535]

As a matter of fact, after 1855, many academic architects regarded iron as a material that modern industry put at their disposal to generate specific types of architecture for specific programs and to be used in practical ways with traditional masonry structures. Architects employed iron despite its aesthetic weakness because of functional and structural needs, and then enveloped it with a monumental stone exterior. Barrault and Bridel, the architects of the Palais de l'Industrie (1855, demolished in 1898), defended their masking of the interior iron structure under the classical facade in this respect.(figs.82, 83) For the interior, they used iron structure rationally. They wrote in the Le Palais de l'Industrie et Ses Annexes,

> . . . , nous avons presque partout montré à nu la fonte et le fer, employés suivant les lois imposées par les sciences et la nature des matériaux. . . la simplicité des formes et la grandeur intérieure de l'édifice suffiraient pour lui donner un caractère particulier portant le cachet de sa destination, et par conséquent acceptable par les publics et même par les artistes d'un sens droit. [536]

However, when Hector Horeau criticized the masonry envelope for reducing the effect of lightness of the building, they responded: "Le métal convient parfaitement partout où il y a des efforts considérables à supporter, mais son prix élevé, la facilité avec laquelle il conduit la chaleur, son aspect disgracieux doivent le faire proscrire des parois sous toute autre

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[535] Ibid.

[536] A. Barrault and Bridel, "Introduction," Le Palais de l'Industrie et ses Annexes (Paris, 1857) p. 2

forme que celle du chaînage vertical oü horizontal. . . . La maçonnerie ne participe à aucun de ces inconvénients."[537]

Victor Baltard's remark on the use of an iron frame in the roof the church of Sainte.-Augustin confirmed their logic for using iron.(fig. 100) He wrote in 1859:

> L'emploi de la pierre pour les murs extérieurs et de refend combiné avec celui de la fonte pour les supports et les nervures des voûtes, qui étonnera peut-être dans la constrcution d'une église, n'est cependant que l'application *rationnelle* des resources que l'industrie met à la disposition des constructeurs. Si l'on peut y trouver quelques inconvénients, on doit reconnaître qu'il y a de grands avantages et particulièrement, celui d'une combinaison simple, économique, solide, qui affranchit de la nécessité des contreforts et des arcs-boutants en dispensant des appareils stéréotomiques qui font la poussée des voûtes.[538]

This practical way of using iron and stone with their own separate logic was firmly established during the Second Empire, not only in the construction of architecture but also in the education in the Ecole des Beaux-Arts. In the École competitions during the 1860s, either in *Concours d'Émulation* or *Concours du Prix de Rome*, there were many projects where an iron interior hall was combined with a monumental stone facade.[539] (figs. 107, 108, 109) In sum, despite Viollet-le-Duc and rationalist avant garde architects' visionary designs for iron architecture and their few experiments with the advanced technology of iron construction, the architectural culture of the Second Empire was characterized by the separation of art and industry, and of interior and exterior.

Thus, there seemed two options left to rationalists. One was to endorse industrial buildings as a new modern style of architecture as such. In this respect, it is very

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537 Ibid., "Conclusions générales," p. 37. Also, Hautecœur, op. cit., p.316

538 Victor Baltard, Rapport au Préfet de la Seine sur la Construction de l'Église Saint- Augustin, 7, (December 1859) Quoted in Bertrand Lemoine, L'Architecture du fer, France: XIXe siècle, pp. 267-268

539 1865 vast hôtellerie pour des voyageurs by Noguet; 1867 Palais pour L'Exposition des Beaux- Art by de Bénard and de Mayeux; 1872, Museum d'histoire naturalle de scellier, de Barth; 1877 L'Athenée pour une ville capitale nénot. All had iron glass roofs. See Lemoine, L'architecture du fer

interesting to see that C.- A. Oppermann, an engineer and a major promoter of iron during the nineteenth century, argued in 1866 that modern style of architecture of iron was already fulfilled.[540] In this case, however, architects would virtually become useless. The other was, as Daly did, holding to the concept of architects as specialist of form, withdrawing themselves from the technological rivalry with engineers. But, in this case, the question would be how to keep the rationalist agenda of the reconciliation of aesthetics and modern science and technology. In the following two decades, the dilemma of rationalism between technology and form became more apparent, and architects were confronted with the ultimate choices, which will be dealt with in the following two chapters.

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[540] Frances H. Steiner, French Iron Architecture (Ann Arbor: UMI press, 1984)

Chapter Eight: Aesthetic of Iron and Renewal of Rationalism, 1870-1889

Republican Aesthetic Ideology and Emergence of the Aesthetics of Iron, 1878

As we have seen, the categorical separation between art and industry during the Second Empire, supported by the Academy and the Ecole, rendered it inherently difficult for Viollet-le-Duc and the rationalist school to create a new style through a rational application of iron. Iron was considered a non-aesthetic material and thus, while iron continued to be used for practical and economic reasons, its use was limited to interior structure and, except for a few utilitarian buildings, was completely concealed behind stone facades. Viollet-le-Duc and the rationalist school's inability to come up with a rational style, therefore, as I argued in the previous chapter, is believed to originate from the inherent contradiction in their principles, mainly, their belief in an architect's reason to raise technology to the level of art in spite of the categorical separation between art and technology.

However, after 1870, the situation changed. First of all, the development of new technology of *pan de fer* in the mid-1860s made it technically feasible to build a multistory iron skeleton building with exposed iron structure.[541] The abolishment of the Paris building code which required a minimum front wall thickness of 50 centimeters was instrumental in carrying the iron frames right into the facade by abolishing load bearing masonry walls. The space between the iron frames was often filled with a combination of terra-cotta and bricks. (figs. 110, 111, Chocolate factory at Noisiel) Responding to greater resistance and economy of material and space, the application of iron skeleton construction

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[541] Les halles centrales, completed in 1863, was the precursor of the iron frame building, but it was considered a utilitarian building. The most celebrated building of *pan de fer* was Saulnier's chocolate factory at Noisiel (1868- 1872). For the development of *pan de fer*, see Frances Steiner, French Iron Architecture, pp. 101-108.

gradually expanded even to the construction of apartment buildings during the 1870s.[542] (figs. 112, 113) An iron skeleton structure with exposed iron columns and beams fundamentally challenged architects' conventional aesthetic norms based on masonry structure. Although the architects decorated the iron elements with classical ornaments, there were limitations in their attempts since an iron frame allowed little space for volumetric expression of masses which was a requirement of classical aesthetics. Louis-Charles Boileau, the son of L.-A. Boileau and a Beaux-Arts trained rational architect, noted this dilemma, and suggested a new aesthetic standard for iron architecture, based on void spaces rather than on solid masses. Explaining the grand staircase of the department store, Bon Marché, which he built in 1876 with the engineer Gustave Eiffel, Boileau wrote: (fig. 114)

> l'exiguïté métallique des colonnes et des fermes offre peu de ressources pour faire valoir les divers plans de surfaces transparentes, et les géométral ne permet pas d'accuser par les effets pittoresques l'air et la lumière qui font presque tout le charme de ce genre d'édifice. . . .
> . . . les étuds ordinaires de l'architecte y sont de peu de secours; à quoi peut bien servir d'avoir appris à disposer et à proportionner des moulures ou des ornements sur des surfaces pleines en pierre dans lesquelles on trouve si aisément les ressauts, les frises, les corniches, les bossages ou les panneaux, en un mot tous les clichés architectoniques que l'on s'exerce à rajeunir sans cesse par de nouvelles combinations, lorsqu'il n'y a plus de surfaces disponibles pour le recevoir? . . .
> . . . . ce point de vue devra consister à envisager non plus les pleins de l'édifice, mais bien le vide qu'il enveloppe, c'est-à-dire qu'au lieu de chercher à faire jouer la lumière sur des formes plastiques, il faut l'opposer à elle-même dans l'air ambiant qui circule à travers la construction, et, par sa profusion ou son économie, créer des éclats, des demi-jours ou des reflets qui fassent scintiller la clarté dans l'espace comme on fait jeter des feux aux cristaux des lustres en y taillant des prismes divers.

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542 See Barré, L.-A., "Maison avec façade en pan de fer apparent," RGA (1879), p. 98-100

Dans ce concert lumineux, l'architecture solide jouera le rôle de la sertissure d'une pierre fine...[543]

This new aesthetic experience of iron construction was not unrelated to the aesthetic revolution in painting and literature which started in the mid-1860s and was well underway in the 1870s, challenging the classical aesthetic norms of the Academy. In Impressionists' paintings, such as those of Manet, Monet and Renoir, the traditional aesthetic norms based on the interplay of light and shadow on solid masses were rejected. Aiming at a more objective representation of nature in open air, they experimented with new ways of aesthetic representation using bright colors and depthless flat surfaces. Instead of the traditional subject of historical settings, the Impressionists and Naturalists celebrated the modern middle class leisure life --such as family picnics and gas-lit boulevards of Paris, cafe concerts and landscapes, etc.--with the new techniques. During the 1860s, these anti-academic paintings by Realists and Impressionists were rejected by the official Salon.[544] However, after their first exhibition in 1874, the Impressionists held their annual exhibits in the salon. These anti-academic aesthetic principles in paintings and literature were closely connected with the new aesthetic sentiment that iron construction evoked: airiness and depthlessness, fleetingness and lightness of structure as experienced in the iron buildings such as train sheds, theaters and market halls of that time. Therefore, it was not by chance that iron buildings frequentlt became a subject of the Impressionist painters and Naturalist writers. (e.g., Monet's Gare St.-Lazare, 1877, fig.115)

It is not surprising then that critics of modern art anticipated in iron constructions the emergence of a new modern architectural style equivalent to Impressionism and Naturalism. In his review of the 1879 Salon, J.-K. Huysmans, an art critic, advocating the aesthetic revolution in modern arts by the Impressionism of Manet and Monet, and the

543 Boileau, "Magasins du Bon Marché, à Paris: Grand Escalier," Encyclopédie d'architecture (1876), p. 120. In 1900 Robert de la Sizeranne completely reversed this argument, stressing aesthetics of solid masses. Thus he argued that iron should be a support.
544 For example, see the famous Salon des refusés in 1864.

Naturalism of Zola and Flaubert, argued that the same sort of a new style was materializing in iron architecture:

> J'ai souvent pensé avec étonnement à la trouée que les impressionnistes et que Flaubert, de Goncourt et Zola ont faite dans l'art. L'école naturaliste a été révélée au public par eux; l'art a été bouleversé du haut en bas, affranchi du ligotage officiel des Écoles.
>
> Nous voyons clairement aujourd'hui l'évolution déterminée en litterature et en peinture; nous pouvons également deviner quelle sera la conception architecturale moderne. Les monuments sont là: les architectes et les ingénieurs, qui ont bâti la gare du Nord, les Halles, le marché aux bestiaux de la Villette et le nouvel Hippodrome, ont crée un art nouveau, aussi élevé que l'ancien, un art tout contemporain, approprié aux besoins de notre temps, un art qui, transformé de fond en comble, supprime presque la pierre, le bois, les matériaux bruts fournis par la terre, pour emprunter aux usines et aux forges la puissance et la légèreté de leur fontes.[545]

In his review of the 1881 Salon, Huysmans asserted that the iron constructions indicated the emergence of new style in modern architecture. After reviewing iron buildings erected during the 1860s and 70s, such as iron markets, Exposition buildings, the Hippodrome and the Bibliothèque Nationale, Huysmans argued: "Dans tous ces monuments dont je viens de passer la revue, nul emprunt aux formules grecque, gothique ou renaissance; c'est une forme originale neuve, inaccessible à la pierre, possible seulement avec les éléments métallurgiques de nos usines."[546] (fig. 116) He then directly challenged Garnier's thesis that iron is a material for hangars and only a means for architecture. Huysmans wrote:

> J'ai peur que M. Garnier se soit trompé lorsque, dans son volume *A travers les arts*, il a écrit des phrases de ce genre: "Le hangar, voilà la destination du

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545 J. K. Huysmans, "Le Salon Officiel de 1879," L'Art moderne (Paris, 1883), pp. 75-76

546 Ibid., p. 220: In none of the monuments I have just reviewed, is there any borrowing from the Greek, Gothic, or Renaissance Styles. They have a new, original form that cannot be achieved with stone and is possibly only with the metallurgical materials produced by our factories.

métal. . . ., ils ne constituent pas pour cela une architecture particulière." Mais qu'est-ce qui la constitue alors?. . . . le romantique forcené . . . . ne peuvent accepter le magnifique simplicité d'un art qui se préoccupe peu des bariolages et des dorures! [547]

He once again related the new style of iron architecture to the anti-academic aesthetics of Naturalism and Impressionism: "Comme la peinture qui, à la suite des impressionistes, s'affranchit des désolants préceptes de l'école, comme la littérature qui, à la suite de Flaubert, de Goncourt et de Zola, se jette dans le mouvement du naturalisme, l'architecture est, elle aussi, sortie de l'ornière et, plus heureuse que la sculpture, elle a su créer avec des matières nouvelles un art nouveau."[548] Huysmans then ended his writing by quoting Claude Lantier's prediction in Emile Zola's Ventre de Paris (1873). Referring to Les Halles, he wrote: " C'est une curieuse rencontre, dit-il, que ce bout d'élglise encadré dans cette avenue de fonte; ceci tuera cela, le fer tuera la pierre et les temps sont proches. . . c'est l'art moderne qui a grandi, en face de l'art ancien. Les halles sont une œuvre crâne et qui n'est encore qu'une révélation timide du XXe siècle."[549]

The view that iron construction represented a new aesthetic model was shared by Republican politicians and critics. After the defeat of the Franco-Prussian War and in the aftermath of the Commune in 1871, the immediate agenda of French society was to overcome economic depression and class antagonism which they believed had been exacerbated by industrialism. Republican politicians such as Jules Ferry (1832-93), Jules

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547 Huysmans, "Le Salon Officiel de 1881,"La Revue littéraire et artistique (Nov. 1881). Also L'Art moderne (Paris, 1883) p. 220-221: "I am afraid that M. Garnier was wrong when , in his book titled A Travers les Arts[1869], he wrote sentence of this kind; Metal is destined to build hangars... What does constitute it, then... the raging romantic who... could not accept the magnificent simplicity of art that has very little concern for gliding and odd medleys of colors." Translation by Holt in The Expanding World of Art, 1874-1902, p. 37

548 Ibid., p. 222

549 Ibid.
This piece of a church (the church of Ste.-Eustache) tucked into this street of cast iron (Les Halles) is an interesting discovery. The latter will kill the former, iron will kill stone-and the time is near....modern art has grown up in opposition to old art. Les Halles are a bold piece of work-and only a timid revelation of what the twentieth century has to offer.

Simon (1814-96), Victor Hugo (1802-85), Edouard Lockroy (1840-1913) and Antonin Proust (1832-1905) believed that the formation of a morally and aesthetically sound middle class was crucial to rebuild a sound society. This agenda, they maintained, should be met by facing industrialism and by taking advantage of science and technology for the benefit of the society, rather than by avoiding it. They believed that art could help individuals deal with the challenges of industrialization and modernization. Thus, the reconciliation of industry and art once again was considered crucial. Taking their cue from industry in which individuals were organized to make a whole, the Republicans focused on reorganizing the industrial process to make it appear aesthetic and moral.[550]

The desire to achieve the unity of art and science in order to build a harmonious social order, and to use art for this social and moral purpose were not new. As we have seen in chapter five, during the previous Republic there had been a positivistic utopian belief in the unity between art and science as a foundation stone for a sound liberal democratic society. However, this belief was sustained only temporarily; during the Second Empire, art and science diverged. The Republicans of the 1870 and 80s thus had to fight to keep liberal Republicanism viable by focusing on art's direct influence on human psychology, "artificially stimulating the wellsprings of middle class psychological and economic drives,"[551] so that they could be made harmonious with the industrial order. The focus was on having art transform patterns of moral and economic behavior so as to control the development of the highly impersonalized system of production and marketing. Republicans elites, therefore, provided an art policy to cultivate sound middle class aesthetics, which would assist to establish new criteria and new style in which science and technology were made to serve artists' objectives; while science aided artists to understand

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[550] For the Republican aesthetic ideology, see Miriam R. Levin, Republican Art Ideology in Late Nineteenth-Century France (Ann Arbor: UMI Research Press, 1986) Especially, Chapter 1 and 2.
[551] Ibid., p. 2

their materials, technology provided them with material to inspire new expressive possibilities.[552]

In this respect, iron construction was the best suited model for the aesthetic ideology that Republicans propagated. First, there was an "inspirational" relationship between the aesthetics of iron construction and the ideal social order of Republicanism. For the Republicans, the ideal social order was a system in which small, independent units were the fundamental components of a larger structure which, in turn, clearly expressed a rationally integrated whole without losing a sense of social function of the units. Iron architecture, as an assemblage of industrial parts, was considered to be constructed according to the same system as the Republican social ideal. A rational and economic structure of iron constructions which used the material with maximum efficiency, was also most appropriate for democratic ideals of the Republicans. Secondly, since iron was an industrially mass-produced material with which unskilled labor could cover large public spaces, iron bore a clear connotation of equality, democracy and collectivity which Republicans advocated. Lastly, iron had already been used in the construction of buildings closely associated with middle class life and values that Republicans intended to support.

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552 See Levin, op. cit. Examples of the scientific aesthetics were as follows: Chevreul's color theory, *circle chromatique*" provided a means of identifying colors based on the basis of their physical properties, which gave artists a means to control color effects. George Geuroult write in the GDB of 1882 that science would enable artists to establish the relationships between the arts of design and the physiological properties of vision." This view was also held by Charles Blanc and David Shutter in Les Phénomenes de la Vision, (Paris, 1880). Blanc adopted Cheveul's optical theory (1864). Chevreul and Blanc's research assumed the stimuli and response, and the affective power of art. Color, linear motion and the patterns of visual and auditory stimuli were associated with emotional states and the expression of psychological character; Chevreul's knowledge in chemistry was applied to textile dye; In physics, thermodynamics and atomic theory were applied to art and aesthetic theories; the development of science of human psychology during this periods gave artists a means to create a new reality as well as to communicate it to the viewers.

Miriam Levin wrote on the relationship between science and aesthetics: "All the arts were thought of as logical systems of design in which material and methods were inseparable from a final socially harmonious result desired and . . . line, color and material such as iron, ceramics and glass had certain physical characteristics in common that made it possible to consider them in terms of general principles of structure and expression . . . .

A kinship between the new style and science lies in the acceptance of scientific procedures as the basis for artistic composition. Essential characteristic of structural elements are identified and arranged so as to express their relationship to one another like scientist use math equations to express such relationship. .

Science also offered an image of universe as a rationally ordered system, filled with atomic particle in dynamic tension fit with the view of democratic society as collection of rational being. While color theory and psychology of vision offered the way to control the ordering into harmony, the general theory of matter offered a vision of social harmony." Ibid., p. 150

Iron constructions such as market halls, railway stations and other buildings for leisure, which had once been regarded only as industrial hangars, were, thus, now valued by Republican critics as a new conception of modern architecture.

The most dramatic emergence of iron architecture during the Third Republic appeared in the two Paris World Expositions held in 1878 and 1889. The 1878 Paris World Exposition was planned in 1876 right after the Republican win of the election in the same year. The underlying goal of the Exposition was to demonstrate to the outside world the recovery of the French economy and the advancement of her industry. The competition for the exhibition buildings was held in 1876 and the two major buildings, the Palais du Champs de Mars and the Palais du Trocadéro, designed by Engineer Eiffel and architect Hardy, and architect Davioud respectively, were completed within two years.(figs. 117, 118, 119) As Jules Simon, the Minster of Public Instruction, Religion and Fine Arts, who headed the 1878 Exposition, highlighted in his report to the 1878 Exposition, the Republicans chose iron as material for Exposition buildings not only for practical reasons but also aesthetic reasons. After unsuccessful efforts by architects such as Vaudoyer and Hittorff to create a new architecture, he argued, it was inevitable that iron construction should enter the genre of architecture based on its new aesthetics. He wrote: "Quand un siècle ne peut pas s'élever jusqu'à la poésie, c'est quelque chose encore d'avoir de belle prose . . , il faut autant de génie architectural pour construire une halle que pour élever une église. Nos immenses villes, nos chemins de fer ouvrent en ce genre à l'art de l'architecte et de l'ingénieur des perspectives nouvelles et considérables."[553] Baltard's central market, he argued, brought us in this respect a completely new world. And referring to the Palais du Champs de Mars, he stressed a new aesthetic possibility of the iron construction: "Il serait souverainement injuste de méconnaîre la beauté de ces grandes cages de verre,

[553] Jules Simon, "Introduction," Rapports du Jury International Exposition Universelle Internationale de 1878 à Paris (Paris: Imprimerie Nationale, 1880) pp. 220-221

surtout quand, à cette lumière et à cette légèreté on donnait habilement le support de quelques massifs qui reposent et arrêtent la vue."[554]

At the time of the Exposition, Charles Blanc, a member of the *Académie des Beaux-Arts* and a professor of aesthetics at the *Collège de France*, wrote an essay on architecture of the 1878 World Exposition, which was reproduced on three different occasions.[555] Blanc, a socialist Republican, was nonetheless a conservative art critic during the Second Empire, who separated the beautiful from the useful in his Grammaire des arts du dessin (1861-4). However, this time, he changed his position and advocated iron construction as a new architectural style representing modern democratic civilization. He wrote:

> Si l'architecture est, plus encore que tout autre ouvrage de l'esprit, l'expression des sociétés, il est clair qu'une civilisation nouvelle s'annonce et que les générations futures composeront un monde nouveau. Quel sera ce monde?. . . Mais ce n'est pas pour rien que l'architecture est entrée dans l'âge de fer, et ce n'est point le hasard qui lui a donné à résoudre ce problème: couvrir des espaces immenses où des multitudes innombrables, où des peuples entiers puissent se réunir, à l'abri des intempéries de l'air, sans que ces espaces soient encombrés de colonnes ou de piliers, sans que la place d'un seul homme lui soit disputée par un point d'appui.[556]

Blanc attributed the development of the huge iron halls specifically to the Republican value of democracy. "De nos jours, he wrote, l'avènement de la démocratie conduit les architectes à se faire ingénieurs et à chercher dans les constructions en fer la solution du problème qui consiste à réunir sous un abri commun des multitudes sans nombre."[557] Reviving the utopian positivism of the 1840s which believed in the ultimate unity of art and

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[554] Ibid., p.221
[555] Charles Blanc, "Exposition universelle: Architecture, Construction en Fer," part 2, Le Temps (1 May, 11 June, 1878) Les Beaux-Arts à l'Exposition (Paris: Libraire Renouard, 1878) pp. 21-41. The same article was also reproduced in Le Moniteur des Architectes (1878)
[556] Charles Blanc, ibid., p.7
[557] Ibid.

science, Blanc claimed that the iron architecture, by satisfying the new social needs and new sentiments of the democratic society, would have to receive the "baptême de l'art."

> Aux multitudes qui veulent se réunir, aux peuples qui aiment mieux s'associer et s'entendre que de se combattre pour s'exterminer, il fallait des édifices nouveaux, des temples dont la construction répondît à des sentiments qui n'existent qu'en germe dans l'humanité, à des besoins qu'elle n'avait pas connus jusqu'ici, à des idées qui se développeront à l'abri même de ces temples. Lorsque ces prodiges, qui n'en sont encore qu'à leur commencement, auront reçu le *baptême de l'art*. Lorsque la grâce aura consenti à se marier avec utile, on pourra dire vraiment que l'architecture révèle et consacre un nouvel ordre des choses. [558]

Blanc did not forget to mention that aesthetics of iron construction should be appreciated on completely new norms of lightness, mobility and fleeting experience of modernity.

> L'appareil qui contribue si puissamment à la beauté de l'architecture en pierre ne saurait être accusé dans la construction en fer, comme il est, par exemple, dans la composition d'une grille, parce qu'il présenterait à l'œil une complication fatigante de lignes sèches et formerait un spectacle sans repos. L'architecture en pierre produit d'heureux effets par le contraste des parties pleines et lisses avec les parties évidées et ouvrées; mais le fer, étant d'une extrême minceur dans tous ses pleins ou plutôt n'ayant pas de pleins, manque, en son aspect général, de tranquillité, de gravité et de la dignité convenable aux édifices qui n'ont pas une destination du pure utilité . . .
>
> Légèreté et puissance, hardiesse et durée, telles sont les qualités que peut obtenir l'architecture dans la construction en fer.[559]

The utopian vision of iron construction and the new aesthetics of iron were also redeemed by a naturalist novelist, Emile Zola. After the 1878 Exposition, Zola, reviving

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558 Ibid. My italic.
559 Ibid.

Fouriest utopian ideals, postulated a vision of a new public architecture of iron in the modern city:

> Magnificence was created through simplicity, by the logical accommodation to use, intelligent choice of materials and decoration... Down with Greek temples,.. Down with Gothic cathedrals - belief in legends was dead! Down with the Renaissance..., it would never house modern democracy! What was wanted was an architectural formula to fit that democracy,... building it could feel was its own.., something big, strong and simple, the sort of thing that was already asserting itself in railway-stations and market-halls, the solid elegance of metal girders. [560]

In sum, iron construction, which had been considered an industrial hangar, now emerged as a new aesthetic model embodying the Republican values and their scientific aesthetics. The utopian association between iron construction and mass democracy, and the image of iron as an anti-elitist, democratic material had existed since its introduction to architecture in the 1840s, as discussed in previous chapters. The most conspicuous difference in the appreciation of iron under the new Republicanism, however, was that iron buildings were appreciated not only for their symbolic representation of mass democracy but also for their own aesthetic quality.[561]

<u>Architects vs. Engineers: Renewals of Architectural Rationalism</u>

Viollet-le-Duc, a theoretician of Gothic structural rationalism, was a liberal Republican and greatly influenced the general plan of the 1878 Exposition as well as the competition for the Exposition halls. In 1878, after the Exposition, Viollet-le-Duc wrote a series of articles on the iron Exposition buildings in <u>L'Art</u>. In these articles, he considered the iron Exposition

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560 Emile Zola, <u>The Masterpiece</u> (Ann Arbor: University of Michigan Press, 1968) p. 138.

561 Although structural rationalists such as Viollet-le-Duc had advocated an honest expression of material and the mode of construction as the principle of architecture during the Second Empire, iron itself was not appreciated in aesthetic terms. As already discussed in the previous chapter, this was certainly one of the underlying reasons, along with technical and practical considerations, why the rationalists rejected pure utilitarian constructions of iron.

buildings as a material realization of his rationalist principles.[562] He praised the general disposition of the Palais du Champs de Mars from a technical and functional point of view: for instance, because of the expansion of iron and functional necessities for the exhibition, parts of each hall structure were made independent so that it worked as an expansion joint. He especially praised the use of iron in the *Galeries des Machines*. (fig. 120) Viollet-le-Duc also explained that the forms of iron domes and columns which were adopted in the Palais were actually based on his rationalist principles. He argued that the adoption of a system of composite boxed columns of riveted plate iron allowed to obtain "toute la rigidité désirable en tenant comte cependant de l'élasticité nécessaire."[563] In all, Viollet-le-Duc admired the builders' efforts to create rational architecture: "Le constucteur songe à adopter franchement la structure de fer suivant les conditions même de la matière employée; il tente d'abandonner ces systèmes qui avaient la singulière prétention de donner au fer les formes et apparences propres à la pierre ou au bois; il cherche d'abord à établir les combinaisons résultant des propriétés de la matière, puis il en compose la forme apparente."[564] Viollet-le-Duc then claimed that the Palais du Champs de Mars was also satisfactory to the eyes. For him, the curves of the dome of the Palais du Champs de Mars, especially, was satisfactory precisely because its form was given by calculation. He wrote, " . . .par l'observation de ce principe scientifique, le constructeur moderne obtient des ensembles satisfaisants pour les yeux."[565] The Palais du Champs de Mars thus confirmed his rationalist principle that beauty comes from the rational application of the material and the mode of construction. Recapitulating his rationalist aesthetic theory, Viollet-le-Duc wrote once again: "Quand, de sentiment, ou par une méthode purement empirique, une forme

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[562]Viollet-le-Duc, "Les Bâtiments de L'Exposition Universelle," L'Art. vol. 13/14 (1878) p. 195-98, P.137-140
[563] Ibid., p.199
[564] Ibid., p.139
Builders dream of adopting a structure of iron that would exploit the intrinsic qualities of the material. He attempts to abandon the systems that have the singular pretension of giving the iron the forms and appearances proper to stone and wood. . . combinations resulting from the properties of material.
[565] Ibid.

architectonique satisfait les yeux et l'esprit, on peut être assuré que le calcul démontrera que cette forme est celle qui est commandée par les lois de la science."[566]

However, it was engineers rather than architects who provided the judicious employment of the material and the rational forms derived from mathematical calculation and functional necessities. The role of architects here remained minor as mere decorators. The engineers of the Palais du Champs du Mars, on their part, however, had their own concern about the conventional aesthetic habit of monumentality, especially, for the facades of the vestibule.(fig. 121) In a monograph on the constructions of the 1878 Paris Exposition halls, the author wrote: "Leurs [les grands vestibules of the palais du Champs de Mars] façades. . . devaient aussi comporter un caractère monumental en rapport avec l'importance de la construction."[567] For this purpose, they used two boxed columns of plate iron decorated with terra cotta (fig. 122) He wrote:

> La décoration des deux vestibules a été obtenue, en grande partie, par l'emploi de faïences émaillées (Terra cotta) du côté extérieur, et de panneaux en staff du côté intérieur, fixés entre les deux fers plats qui constituaient les plates-bandes des piliers montants. Cette disposition mise en usage pour la première fois, a produit d'autant plus d'effet que quelques-unes des faïences étaient exécutées d'une manière remarquable.[568]

This method, however, necessitated giving to the columns the dimensions "qui dépassaient notablement celles qu'une économie bien entendue du métal aurait fait admettre."[569] Thus, the engineers were obliged to compromise a rational construction of iron with monumental aesthetics. He, then, admitted the inevitable contradiction in the use of iron in monumental construction.

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566 Ibid., p.195
567 Monographie des Palais et Constructions Diverses de l'Exposition Universelle de 1878 à Paris. (Paris: 1882) p.7
568 Ibid., p. 9
569 Ibid.

C'est là, d'ailleurs, la principale difficulté que l'on rencontre dans les constructions métalliques. En raison de sa résistance considérable, le fer se prête peu aux effets monumentaux. On est placé entre deux écueils: celui d'adopter des formes rationelles au point de vue de l'art de la construction, mais grêles et peu satisfaisantes à l'œil, ou d'admettre des formes architecturales, mais ne répondant pas au minimum de dépense que l'on doit chercher à obtenir.[570]

Of course, Viollet-le-Duc was critical of the engineers' effort to monumentalize or "faire de l'architecture" of the otherwise honest iron structure. He criticized the builders of the Palais du Champ de Mars for not following the rationalist principle to its limit, "in parts, in the detail of structure and in all the architectonic forms." Although he admitted that it was very difficult to rid oneself of traditions and prejudices, he nonetheless criticized the builders: ". . .il a prétendu faire des concessions à une architecture de convention;. . . Il a cru à la nécessité du *monumental* et ce soi-disant monumental vient s'imposer d'une façon assez gauche."[571] Viollet-le-Duc also criticized the architects's clumsy intervention to give the facade of the Palais a monumental pretension, especally in two corner pavilions.(fig. 123): "Evidemment l'architecte, auquel le constructeur du Palais du Champs de Mars s'est adressé pour apporter un appoint d'art à ce vaste bâtiment, n'a pas compris que cet appoint d'art devait se soumettre absolument à la conception structurale, qu'il devait l'appuyer, non la masquer."[572] Reclaiming his rationalist principle that decoration should be derived from the constructional logic, he criticized the architects of the Ecole of lacking the ability to provide proper decorations.

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570 Ibid.

571 Viollet-le-Duc, "Les Bâtiments de L'Exposition Universelle de 1878," L'Art, vol. 13/14 (1878) p. 139: "He (the builder) has pretended to make concessions to a conventional architecture... He believed in the necessity of the monumental and this monumental imposes itself in a somewhat clumsy fashion."

572 Ibid., p. 140
evidently the architect, who were asked by the builders of the palace to add decorations to this vast building, did not understand that this decoration ought to be entirely subordinated to the structural conception, which it should not mask, but strengthen.

However, if one followed Viollet-le-Duc's argument laid down here, the creators of new architecture would become engineers, rather than architects. In fact, as discussed in the previous chapter, Viollet-le-Duc's concept of rational beauty was an ambiguous one, based on a mixture of a Gothic model and scientific rationality of structure; while arguing for a consistent expression of structural rationality, he still preferred the simultaneous use of iron and masonry walls as the supporting system, which was inconsistent in terms of not only structural statics but also production processes, and used them as an indicator to distinguish artistic architecture from iron hangars.[573] This ambiguity in his structural rationalist principle was made evident with the emergence of exposed iron frame buildings, called *pan de fer*, in the late 1860s. The exposed iron frame buildings made it apparent that there was a gap between the real mathematical rationality of structure and the structural rationality that Viollet-le-Duc had in mind. Explaining his iron double roof structure of the Bon Marché in 1876, Louis-Charles Boileau, the architect of the Bon Marché, accurately pointed out the problem with the structural rationalist aesthetics of the correspondence between decoration and construction. Separating between real and appearance of structure, he argued for the *vraisemblable*, a visual expression of the structural rationality, rather than real construction, as the true principle of rational architecture:

> ... le vrai, en architecture comme en tous les arts, n'est que le *vraisemblable*: c'est-à-dire que ce ne sont pas les qualités intrinsèques des matériaux, leur fond vrai qui doit influencer leurs formes, mais bien les qualités apparentes sous lesquelles ils se présentent aux yeux: leur fond vraisemblable. Il est juste de dire que l'apparence et le fond peuvent parfois se confondre; mais il est non moins évident que très souvent ils s'éloignent l'un de l'autre fort sensiblement.
> .... parce que la conscience de la poussée des voûtes comme celle de bien d'autres effets complexes de la construction échappe à notre sens artistique, tandis que notre œil sera toujours choqué de voir, par exemple, une

[573] See Viollet-le-Duc, Entretiens, Unlike Boileau who preferred stone envelope but separated them, Viollet preferred the organic integration between the two materials.

> pyramide tronquée posée sur son tronc, bien qu'en réalité l'equilibre puisse en être parfait au point de vue de la science
>
> Le vrai n'est donc pas toujours vrai pour nos sens et le vaisemblable seul qui se résume en équilibres apparents, c'est à dire en *proportions*, doit être le point de départ du beau, en architecture.
>
> . . . . Le fer a sa raison d'être pour l'ossature de surface que l'on veut élever dans l'espace, comme les voûtes et les plafonds; il ne s'appliquerait à des murs ou à des piles d'angle et en général à tous les ouvrages dont l'effet spécial doit être de présenter à l'œil une grande stabilité, qu'au grande dommage de la vérité artisque.
>
> Tout donc nous porte à croire que ces matières métalliques, ... loin d'envahir le domaine de la construction artisique, devront se localiser dans des emplois déterminés conséquents avec leurs propriétés réelles et sous des formes en harmonie avec leurs effets apparents.
>
> Les monuments y gagneraient d'être un peu plus artistiques que ces sortes de halles dont on a tant abusé, sans rien perdre de l'effet intense de ces immensités lumineuses enveloppées sans efforts, qui constitue un des côtés vraiment nouvaux et remarquables de l'architecture du xixe siècle.[574]

If architecture is more than a simple expression of the consistent load bearing behaviors of material, architectural form or decoration should be separated from the real constructional rationality, as Boileau suggested. Otherwise, one had to endorse rational constructions of iron industrial buildings as an architectural art as such. In fact, Viollet-le-Duc seemed to have finally accepted the aesthetics of exposed iron buildings. In the eighteenth lecture of the second volume of the Entretiens, published in 1872, Viollet-le-Duc himself suggested a house of *pan de fer* with brick infilling walls as a possible model for future architecture.[575] (fig. 124) However, although the ceramics and bricks used between

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[574] Boileau, op. cit., p. 122-123

[575] Viollet-le-Duc and the GAB in fact published Saulnier's chocolate factory in 1868. However, the question of the masonry wall was not completely resolved. It was for this reason that Viollet-le-Duc ironically praised the palace du Trocadéro, built as a permanent building, with a mixture of iron and masonry with eclectic formal vocabulary, as an architecture where "rationalist principles were well respected and judicious employment of material according to their destination and their properties, the sincerity of means adopted."[575] While other critics criticized it as irrational due to its arched window and buttress. (RGA, 1878) In fact, the Palais du Champs de Mars that Viollet praised as a realization of his rational principle, was built as a temporary building.

the exterior iron frames could provide a new anti-classical aesthetics based on constructional logic, as he argued,[576] it was inevitable that the role of architects in the creation of new architecture became ambiguous.

Already in the 1860s, when he was writing the second volume of the Entretiens, Viollet-le-Duc anticipated that the convergence of architects and engineers was inevitable. He wrote: "If we take a fair and unprejudiced view of things, we cannot shut our eyes to the fact that the professions of the architects and the civil engineers tend to merge one into the other as was formerly the case."[577] Viollet-le-Duc saw the unsatisfactory result of the Palais du Champ de Mar, too, as an inevitable consequence of the collaboration between architects and engineers, who worked with very different principles. He wrote, ". . .quand il s'agit une œuvre d'architecture,. . il est bien difficile, si on veut obtenir un résultat complètement satisfaisant, de faire marcher ces deux éléments lorsqu'ils ne sont pas sortis d'un même cerveau. Le constructeur gêne l'artiste, et celui-ci, bien plus encore, gêne la constructeur. . ."[578] He thus implied, in order to have a satisfactory result of rational decoration, architects and engineers should merge into one and the same person, which would mean the ultimate annihilation of the profession of traditional architects.

In envisioning a new style of iron architecture, Charles Blanc did not differentiate between architects and engineers either. As discussed earlier, for the Republican critics, iron architecture was an art which embodied the modern liberal democratic ideal in that it represented the moral and material aspiration of common men, rather than of a high abstract truth.[579] In this case, an artist became almost indistinguishable from a worker, or a

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576 "Ces remplissages en terre cuite émaillée sont bien la décoration qui convient à la contruction de fer . . . Là l'architecte, loin de chercher à dissimuler une structure de fer. . . n'a fait, par son mode de décoration, qu'appuyer cette structure." Viollet-le-Duc, "Les Bâtiments de L'Expositionn Universelle de 1878," L'Art, vol.13/14 (1878) p. 140

577 Viollet-le-Duc, Lectures on Architecture, vol. II, trans. by Benjamin Bucknell (New York: Dover, 1987) p. 72.

578 Viollet-le-Duc, "Les Bâtiments de l'Exposition Universelle de 1878: Le Palais du Champs-de-Mars," L'Art. vol. 13 (1878) P. 216.

579 Miriam named Blanc's experience of iron buildings in 1878 as "inspirational" as opposed to "normative", that is, the intuitive understanding of a matter, which enabled him to alter it into a pleasing form. See Miriam, ibid., pp. 158-164.

sensitive artisan. It was for this reason that neither Blanc nor Hugo distinguished artists, artisans, engineers and architects. After defining the aesthetics of iron construction as "légèreté et puissance, hardiesse et dureté," Blanc thus stressed, "je dis l'architecture, parce qu'il importe de ne plus distinguer dorénavant entre l'architecte et l'ingénieur. . . . l'ingénieur et l'architecte, loin d'être séparés par une rivalité orgueilleuse, doivent désormais se fondre l'un dans l'autre et ne faire qu'un."[580] Elsewhere in his article, Blanc went as far as to argue that in modern democratic society architects actually became engineers to build iron constructions: "De nos jours, l'avènement de la démocratie conduit les architectes à se faire ingénieurs et à chercher dans les constructions en fer la solution du problème qui consiste à réunir sous un abri commun des multitudes sans nombre."[581]

Consequently, while iron construction emerged as a model for a new modern style representing the Republican ideals of scientific aesthetics and liberal democracy, the role of architects became ambiguous. Although rational-minded architects agreed that iron should be a material for new architecture, and science and art should be reconciled, they were not in complete accord with Viollet-le-Duc and the Republican critics. The architects not only feared the loss of commissions to engineers, but also were deeply concerned about the degradation of art which they believed would come with the complete dominance of engineers. In his lecture given to the 1878 *Congrès International des Architectes*, Émile Trélat, the director of the *Ecole Spéciale d'Architecture*, reflected on this endangered situation of architects and their art: "La profession de l'architecte, considérée dans son plein exercice sur toute la surface de territoire, et surtout loin de Paris, est une profession en souffrance. Ses intérêts sont menacés, son champ d'application se rétrécit, l'ingénieur y pénètre. Il y a lieu de craindre un envahissement. Un pareil événement serait une calamité

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580 Charles Blanc, "Exposition Universelle, Architecture," Le Temps (1878)
581 Ibid.

pour l'art."[582] This perception of the crisis of art and architecture was shared by most architects of the time.

By the late 1870s, therefore, the relationship between architects and engineers, and their respective roles became a crucial issue among rationalist architects. The architects had to find a role in the creation of a new style, against the threat from engineers and industrialization. Not surprisingly, the architects tried to distinguish themselves from engineers by claiming expertise in form and aesthetics. However, a formal aesthetic, in order not to be reduced to a mere decoration separated from construction, should be somehow grounded in modern science and technology without being immersed in mere engineering. Their concern was thus how to find new aesthetic forms that would unite the development of science and engineering with a contemporary aesthetic sentiment.

César Daly, a rationalist turned eclecticist, was one of the early critics who noticed the contradictions within structural rationalism, predicting that the introduction of engineering education to architects would result in the ultimate abolishment of the profession of architects. As discussed in the previous chapter, he had emphasized in 1863 that the main task of architects was the creation of a new form, which he called organic. In 1877, in the closing lecture to the *Congrès National des Architectes Français*, held a year before the Paris World Exposition, Daly addressed the issue of the relationship between architects and engineers.[583] Like Viollet-le-Duc and Blanc, he also believed that the long-standing hostility between architects and engineers was a mistake, based on "erreurs, malentendus and préjudices": Architects wrongly believed in absolute beauty regardless of the development of modern science and technology, whereas engineers depended on a purely rational scientific approach devoid of aesthetic sentiment and imagination; thus, each renounced the other's discipline. However, instead of arguing for the merger of architects

582 E. Trélat, International Conference of Architecture, tenu à Paris, du 29 juillet au 3 aout, 1878, Paris, Congrès et Conférences au Palais du Trocadéro. (Paris, Imprimerie nationale, 1881) p. 170
583 See "Congrès Nationale des Architectes," RGA (1877) p.186. Daly published an article, "Ingénieurs et Architectes," in the same issue of RGA (1877) pp. 160-166.

and engineers like the Republican critics, Daly called for a reconciliation between the two professions. For this, it was important to understand that the two groups have different goals and means of action, based on a division of labor, which was not only a logic of economy but also fundamental for social progress. Daly wrote, "les ingénieurs et les architectes sont les organes complémentaires, mais distincts d'une fonction complexe: celle de l'art de bâtir."[584] Calling engineers the cousins of architects in his lecture, Daly argued that engineers could help architects to develop a new organic architecture: "Je bois, Messieurs, à nos cousins les ingénieurs, aux savants, pionniers occupés à créer les ressources financières et à élaborer des procédés techniques qui aiderons à l'écolision splendide que l'avenir réserve à notre nouvelle et prochaine *architecture organique*."[585]

In this respect, it is interesting to note that Daly, unlike Viollet-le-Duc, considered the engineers' attempts to monumentalize the 1878 Exposition buildings an indication of engineers' aesthetic improvement and thus, a good sign for the reconciliation between the two groups. In his review of the buildings of the 1878 Exposition in RGA, Daly praised the use of boxed columns of plate iron and of terra-cotta in the Palais du Champ de Mars as an attempt to overcome the aesthetic weaknesses of iron. Daly wrote:

> Les constructions en fer ont été longtemps écartées par nos architectes en raison de la maigreur excessive de leurs proportions; cela manquait de corps. Au Champ de Mars, cette maigreur n'existe pas ou n'existe guère, grâce à d'habiles combinaisons du fer avec d'autres matériaux, surtout avec des terres cuites émaillées, dont la coloration, en outre, donne à l'extérieur de l'édifice plus de gaieté qu'on n'en obtient d'ordinaire dans les constructions de métal.[586]

In the review, Daly also took a formal and aesthetic point of view to praise the use of stone for the bases of the corner pavilions, which Viollet-le-Duc had criticized as a clumsy

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[584] Daly, "Ingénieurs et Architectes," RGA (1877) p.161
[585] "Congrès National des Architectes," RGA (1877) p.187
[586] Daly, "Les Deux Palais de l'Exposition: Considérés dans leur rapports avec l'art," RGA (1878) P. 190

intervention of the architects. Daly wrote: "Aux angles des bâtiments, . . . les lignes grêles du métal sont particulièrement défectueuses. M. Hardy a prévu cette difficulté et l'a habilement vaincue, en construisant en pierre, jusqu'à la hauteur de la naissance des dômes, les bases des pavillons latéraux."[587]

Next year, in the *Congrès International des Architectes* held at the time of the 1878 World Exposition, the relationship between architects and engineers became once again one of the major issues of discussion. The 1878 architects' conference was in a sense the architects' response to the problems faced by architecture in modern industrial society and its endangered social role, threatened as it was by engineers and industrialization. Among the speakers, Emile Trélat and Davioud, especially, addressed the issue of the relationship between architects and engineers.[588] In his lecture, "*L'Union ou la Séparation des Ingénieurs et des Architectes*," Davioud, an academic architect who designed the Palais du Trocadéro, focused on how architects might maintain a leading role in architectural production, despite threats from engineers.[589] He criticized those critics who considered "l'extension des ingénieurs dans les travaux des architectes" a beginning of the fusion of art and science. He argued: "ceux-là [engineers] sont juges des concours d'architectes et ils dirigent les travaux des architectes. Mais jamais ceux-ci [architectes] à leur tour, . . n'ont à controler les ingénieurs; une action qui n'est pas réciproque est une absorption."[590] Nor did he consider the fusion of the two groups desirable because engineer's principles contradicted the vital condition of art in which *liberté* and *personnalité* were the prime order. However, although the scientific formulas could not replace architects' creative imagination, he also argued that, in order not to be dominated by engineers who responded better to social needs without formal concerns, architects needed to know about applied sciences. In other words, by learning about modern science, new materials and new

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587 Ibid.

588 Besides them, Hermann presented a paper on aesthetics, and the deceased architect, Baltard's paper was read. See International Conference of Architecture, tenu a Paris, du 29 juillet au 3 aout, 1878, Paris, *Congres et Conferences au Palais du Trocadéro*. (Paris: Imprimerie Nationale, 1881)

589 See ibid., pp. 93-99 and pp. 144-150

590 Ibid., p. 148

methods of construction, while maintaining the architect's specialty in aesthetic forms, he argued, architects could reclaim their leading role in public services.[591] Davioud was, thus, trying to restore the role of architect as the master builder in the traditional sense, who controlled the production of architecture as a whole. This view of an architect, however, was obviously nostalgic and anachronistic in the increasing division of labor in modern industrial society.[592]

Émile Trélat, a rationalist trained in an engineering school, on the other hand, clearly distinguished the role of architects from that of engineers. In his lecture, given as a rebuttal to ones that preceded him, he argued that an architect was a supreme artist and a constructor of forms, endowed with a spiritual role: ". . . l'architecte a une visée supérieure, transcendante, et qui domine toutes les autres, c'est la beauté de l'œuvre, la perfection de sa forme. Ainsi, nous pouvons appeler l'architecte un ordonnateur de formes et même un constructeur de formes."[593] Engineers, on the other hand, he argued, were not at all interested in form: "La forme, l'ingénieur ne s'en préoccupe pas; il n'a pas à s'en préoccuper ; il ne sait pas ce que c'est; il ne veut pas le savoir."[594] Trélat then elaborated on the concept of form in art in terms of contemporary physics: form was the result of the conflict between material and light. He wrote,". . . au point de vue de ses causes, la forme est l'éther vibrant rompu à la rencontre du corps; au point de vue de ses effets, la forme est un phénomène immense qui n'est absolument constatable que par l'œil. . . C'est le monde vu."[595] With the perception of form through the scientific paradigm of a dynamic universe where particles are floating around in the ocean of light, he argued, an architect could organize the conflicting factors in architecture into a new harmonious form.

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591 See Ibid., pp. 144-150

592 The problems that architects faced as a result of the introduction of modern industry and technology were fundamental problems of transformation of the relations of production. (i.e., a categorical separation of reason and sentiment, subject and object, and art and science)

593 E. Trélat, "Enseignement de l'Architecture," op. cit., p. 163

594 Ibid.

595 Ibid., p. 160

Trélat's theory of form clearly adopted not only scientific aesthetics but also the aesthetic elitism advocated by Republicans. Although Republicans did favor anti-elitist democratic aesthetics, as discussed earlier, they at the same time considered artists to have a superior moral position in society. They believed that artists could produce new designs better than copies of old styles. In this way, artists would overcome the deteriorating relationship between art and industry, and between masters and workers, caused by the introduction of machines. Therefore, decorative artists, for instance, in the view of the Republicans, could provide models for mass produced objects, and thus would remain as leaders in the industrial system. However, while decorative artists could play a leading role in the industrial production process, a similar intervention of architects in the production process of iron construction would have been quite inappropriate. Unequipped with the knowledge and skills of engineering, architects would remain as mere decorators of construction. It was in response to this contradiction that Trélat developed highly abstract aesthetic concepts of form derived from modern physics. Trélat's romanticization and aestheticization of modern scientific theories, and the use of them as bases for the creation of a new form, were obviously an attempt to solve the dilemma of architectural rationalism between modern science and aesthetics.

Trélat's position on the role of architects and their relationship to engineers had indeed quite remarkably changed. In 1864, when he founded the *Ecole Centrale d'Architecture* with Viollet-le-Duc, Trélat had argued for the teaching of engineering in architectural schools and eventually for the possible merging of the two professions. However, as was discussed in the previous chapter, by 1868 he was already dubious about the efficacy of structural rationalism of Viollet-le-Duc in the creation a new style, and became more inclined toward a Symbolist approach. In his 1878 lecture, Trélat made explicit his critical view of structural rationalism. "Je serais désolé de voir l'architecte se traîner à la remorque de procédés scientifiques de son émule. . ."[596] He then argued, "Du

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[596] Ibid., p. 164

jour où vous ferez de l'architecte un homme qui posera des équations de stabilité ou de résistance pour chacun des éléments de son édifice; de ce jour là, vous n'aurez plus d'architecte; l'artiste sera mort. Il restera ingénieur."[597] In an essay written two years later, Trélat criticized structural rationalism once again, saying that by the threat of engineers, the architect "essaya de s'approprier les méthodes de construction de son adversaire. Il copia maladroitement des procédés qu'il ne connaissait pas et il faussa ses œuvres."[598] He then directed his criticism toward the determinism of Viollet-le-Duc's Gothic rationalist school:

> Ceux qui admirèrent l'admirable logique des combinaisons *constructives* de notre vieille architecture nationale jusqu'à voir dans la logique de la construction un idéal de l'architecture, avaient une juste idée. . . Mais cela était insuffisant, parce qu'un simple équilibre de matériaux correctement assemblés est loin d'être *ipso facto* un objet pourvu de qualités plastiques."[599]

Emphasizing the formal values in architecture, Trélat then drew a clear distinction between architects and engineers; the one, a designer of a pleasing form, the other, a builder of a utilitarian structure.[600]

Although both Daly and Trélat stressed formal aesthetics as the prime indicator of the distinction between architects and engineers, there was also a difference between them regarding how to create an aesthetic form befitting modern science and technology. Whereas Trélat leaned heavily toward the scientific aesthetic models which were developing under the Third Republic, Daly was critical of these. Daly wrote in the editorial of the 1880 RGA : "De nos jours l'esthétique tend à devenir enfin une science, comme tant d'autres

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597 Ibid.
598 Trélat, "L'architecture Comtemporaine," Nouvelle Revue (1880) p. 93. Originally published in Encyclopédie d'Architecture, in the same year. pp. 40-48
599 Ibid., p. 96-97
600 See ibid.

sciences, un pur instinct complété par des règles empiriques."[601] However, he argued that a science of aesthetics is not sufficient; it is only a guide to art:

> La possession de la science esthétique ne suffit pas, il est vrai, ne suffira jamais à donner le génie de l'art, pas plus que la science de la mécanique mathématique ne donne à qui en est le maître le génie de l'invention mécanique; mais la science esthétique est pour l'artiste, comme la science mathématique pour l'ingénieur, une lumière qui éclaire le terrain, empêche de se heurter contre les obstacle et de trébucher, fait voir des sources où puiser et donne la vraie mesure des forces (ici esthétiques, là mathématiques) à mettre en œuvre.[602]

Daly also maintained that science was not enough even for engineers since all the forms, whether it be scientific or not, were subject to the laws of aesthetics. Although scientific and technical knowledge constitutes 'les premiers chapitres de la grammaire" of constructors, whether they be engineers or architects, aesthetics is "la fin et le couronnement." He then considered poetics and sentiment the ultimate sources in the creation of aesthetic forms:

> Aujourd'hui pour l'architecte, la grande difficulté n'est ni scientifique, ni technique: elle est esthétique and poétique. . . . Aujourd'hui les architectes ont à apprendre de ceux qui le savent, quelles sont les vérités esthétiques qui ont enfin acquis l'autorité qui n'appartient qu'à la science; . . . ils ont à déterminer enfin quels rapports peuvent exister entre les lignes expressives de l'architecture et le génie de la société nouvelle qui se forme sous nos yeux, car l'art architectural est nécessairement l'expression plastique d'une société, ou il n'est qu'une superfétation du génie civil et doit, en ce cas, lui céder la place.
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> Nous n'avons pas en France un chaire où s'enseigne spécialement l'ésthétique architecturale, et les rares livres qui en parlent sont tous plus ou moins chargés d'erreurs et incomplets. . . .

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601 Daly, "Introduction,' RGA (1880) p. 3
602 Ibid., p. 3

> L'esthétique, c'est la science et la philosophie de l'art, la poésie c'est l'artiste lui-même. On devient esthéticien, on nait poète. . . . la nature seule donne le génie poétique, que le travail rend fécond et dont la science double la puissance et la sûreté.[603]

In sum, by 1880 architectural rationalism had changed quite a bit: As iron constructions emerged as an aesthetic model for a new style, rationalist discourses paradoxically retreated to those of abstract formal aesthetics of science and technological forms. The change of rationalism from constructive discourses to a formal, symbolic and aesthetic ones, which was reflected in the theoretical writings of Daly and Trélat, was in a sense an inevitable choice of rationalist architects to secure their role endangered by engineers in modern industrial society.

1889 Paris World Exposition: Limitation of Architectural Rationalism

Aesthetic rationalists such as Daly and Trélat were naturally more reserved in their assessment of the contemporary architectural situation than the art critics who claimed the advent of a new architectural style that paralleled new styles in painting and literature. Writing in 1880, Trélat singled out the absence of the public and proper criticism of architecture as the reason why architecture lagged behind the other arts.[604] The rationalist architects' search for rational aesthetics appropriate to modern science and technology seemed therefore a quite legitimate task. In the early 1880s, the aesthetic rationalists were optimistic about the future of architecture and their role within it. Citing the liberal policy of the Republican government, such as the abolishment of government control of arts and liberal education, Trélat saw the situation as better than ever before for architects to develop a new form of architecture. Trélat wrote in 1880:

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[603] Ibid., pp. 4-6

[604] See Trélat, "L'Architecture Contemporaine," Nouvelle Revue (1880) p. 98

> ... les obstacles que les conditions de vie des gouvernments personnels suscitent à l'évolution d'un art dans notre France de XIX siècle. Ces obstacles ont fortement troublé notre architecture. . . Mais ils n'existent plus. Notre pays épand ses énergies dans le travail, et contrôle lui-même sa marche dans les courants d'une opinion libre. L'architecture ne trouvera jamais un milieu plus favorable au dévelopement ordonné de ses forces et à la pondération de son œuvre.[605]

This positive view, however, could not hold a decade later, when two wrought iron monuments-- the Eiffel tower and the Gallery of Machines-- were erected at the time of the 1889 Paris World Exposition. The two iron monuments realized literally the aesthetic ideal of Republicanism. Assembled with industrially produced parts by unskilled workers to make harmonious whole structures, the iron constructions not only represented the aesthetic model of a democratic society, but also served as a means to educate the workers about the social ideal.[606] Created through scientific calculations and structural necessities, the curved lines and the forms of the Tower and the Gallery were also completely independent from historical styles.(figs.125, 126)

State officials and Republican critics therefore glorified these buildings as a new modern style befitting modern industrial and democratic society. Edouard Lockroy, the minister of culture at the time of the Exposition, who was instrumental in the construction of the tower to celebrate the centennial of the French Revolution, heralded the birth of a new modern style of iron architecture in his preface to <u>L'Exposition Universelle de 1889</u>:

> Les siècles précédents, religieux, militaires, autoritaires et aristocratiques, ont trouvé dans les temples, les palais, les châteaux et les églises leur formule architecturale; notre temps industriel et démocratique n'a pas encore découvert définitivement la sienne. . . . il est certain que nos monuments n'expriment, en général, ni les besoins ni les idées de notre époque.

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[605] Ibid.
[606] See Levin, op. cit.

> Peu à peu, cependant, le style moderne se dégage, et il se formera à mesure que l'industrie et la science mettront à notre disposition de nouvelles resources et de nouveaux matériaux. De plus en plus la fonte, le fer, l'acier, joueront un rôle dans nos constructions, et l'on obtiendra grâce à leur secours des effets inattendus et inconnus jusqu'à présent. . . Des formes apparaissent déjà, qu'on ne connaissait pas: les lignes se combinent autrement qu'autrefois: on voit que l'art du XIXe siecle, on pourrait dire du XXe, va naître. L'Exposition de 1889 aura hâté son éclosion. [607]

In 1890 Roger Marx, Inspector-General of French Provincial Museums, glolified the 1889 Exposition, declaring, "voici . . .que le fer s'est émancipé, que son rôle, d'auxiliaire et caché, est devenu apparent et décoratif et qu'il tend à former l'élément d'un style nouveau, en parfaite concordance avec l'esprit et la fièvre de notre temps."[608]

However, it was once again engineers who were the major contributors to the construction of the iron monuments; the role of architects in these buildings remained mainly as decorators. The Eiffel tower, especially, was a logical consequence of engineering construction; unlike the iron construction of the previous Exposition, it did not pretend to be a traditional monument. However, the tower was not simply an utilitarian construction, but a monumental art with no imminent utilitarian purpose other than representing the Exposition: that is, the advanced state of industrial and democratic culture of France.

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607 Edourd Lockroy, "Preface" to L'Exposition Universelle de 1889," by Emile Monod, 2 vols. (Paris: E. Dentu, 1890) p.XXVI: "The centuries preceding us -- religious, military, authoritarian and aristocratic-- discovered their architectural formulas in temples, palaces, chateaux and churches; our industrial and democratic era must definitely discover its own... in general. our monuments have not expressed either the needs or the ideas of our time. Slowly, however, the modern style emerges, and it takes shape as industry and science put new materials and new techniques at our disposal. The more wrought iron and steel play a role in our construction, the more we will achieve our own distinctive effects. Their lines will combine differently than ever before; this is the art of the 19th century, of the 20th century. . . the 1889 Exhibition has accelerated its birth."

608 Roger Marx, "La Décoration et l'Art Industriel à L'Exposition Universelle de 1889," L'Architecture III, (1890) p. 382. However, Roger Marx, like Huysmans, refuted "striking beauty" of the Eiffel tower while he glorified beauty of the Gallery of the Machines. See ibid.

Despite their elaborated theories of form based on modern science, rationalist architects' role in the creation of the new form of iron construction was non-existent.[609] Academic architects, on the other hand, who considered iron suitable only for engineering buildings and inimical to artistic expression fiercely protested against the construction of the tower, criticizing it as an encroachment of art by industry. When the construction of the tower started in 1887, Le Temps published a letter of protest signed by Garnier, Vaudremère, Daumet, Questel, Gérôme, Guy de Maupassant and many other prominent artists of the time. They wrote:

> Nous venons, écrivains, peintres, sculpteurs, architectes, amateurs passionnés de la beauté jusqu'ici intacte de Paris, protester de toutes nos forces, de toute notre indignation, au nom du goût français méconnu, au nom de l'art de l'histoire française menacés, contre l'érection, en plein cœur de notre capitale, de l'inutile et monstrueuse tour Eiffel, que la malignité publique, souvent empreinte de bon sens et d'esprit de justice, a déjà baptisée du nom de ((tour de Babel)).[610]

Betraying their deep-rooted skepticism toward engineers' faculty of imagination, the artists and architects wrote in the letter, "[I]s Paris going to be associated with the grotesque, mercantile imaginings of constructors of machines, to be irreparably defaced and dishonored.?" [611] However, in defense of his tower against the protest, Gustave Eiffel brought up the aesthetic arguments of architectural rationalism. In his response to the letter published in the same issue of the Le Temps, Eiffel complained:

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609 Trélat and Daly remained mostly silent. They rather tended to adopt the aesthetics of classical formalism such as proportion. In fact, Daly criticized the Eiffel tower from the classical aesthetic point of view, and called for *Haute Etudie d'Architecture*. Trélat applauded the classically decorated the Pont Alexandre in the 1900 Paris Exposition (see Roger-Henri Guerrand, "Art Nouveau and the Beaux-Arts," in AD Profile, New Free Style

610 Le Temps (Feb. 14, 1887). This was also published in Encyclopédie d'Architecture (1887) pp. 58 "We come, writers, painters, sculptors, architects... in the name of French art and history threatened, to protest against the erection in the heart of our capital of the needless and monstrous Eiffel Tower..."

611 Ibid. "La ville de Paris va-t-elle donc s'associer plus longtemps aux baroques, aux mercantiles imaginations d'un constructeur de machines, pour s'enlaidir irréparablement et se déshonorer?

> Je crois, moi, que ma tour sera belle. Parce que nous sommes des ingénieurs, croit-on donc que la beauté ne nous préoccupe pas dans nos constructions et qu'en même temps que nous faisons solide et durable nous ne nous efforçons pas de faire élégant? Est-ce que les véritables fonctions de la force ne sont pas toujours conformes aux conditions secrètes de l'harmonie ? Le premier principe de l'esthétique architecturale est que les lignes essentielles d'un monument soient déterminées par la parfaite appropriation à sa destination. De quelle conditions ai-je eu, avant tout, à tenir compte dans la Tour? De la résistance au vent. Eh bien! Je prétends que les courbes des quatre arêtes du monument, telles que le calcul me les a fournies donneront une impression de beauté, car elles traduiront aux yeux la hardiesse de ma conception.[612] (fig. 127)

By this time, engineers thus adopted the rationalists' aesthetic theory of iron construction. Albert de Lapparent, an engineer, wrote in Le Siècle de fer in 1890, referring to the Eiffel Tower: "Once more by this example, one acquires proof that true beauty in architecture resides essentially in the perfect adaptation of means to purpose, so that the edifice which satisfies best the appearance is justly that in which . . .the fundamental conditions of the construction have best been observed."[613] Vierendeel, a Belgian engineer, even claimed that engineers' ignorance in the matter of art was certainly an advantage over architects for their aesthetic imagination.

> N'ayant guère étudié les styles archéologiques, leur mémoire n'est pas surchargée des types architecturaux antétieurs. . . . [Ils pouvaient ainsi oeuvrer plus efficacement à la création] d'une forme esthétique nouvelle,

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612 G. Eiffel, "Reponse de M. G Eiffel à la Protestation des Artistes," Interview by p. Bourde, Le Temps, (Fevrier 14, 1887): "Is it because we are engineers that we do not pay attention to beauty? Do not the laws of natural forces always conform to the secret law of harmony? The first principle of the aesthetic of architecture is that the essential lines of the monument should be determined by their perfect appropriateness to their end. Now what condition do I have to take into consideration above all others in the tower? Wind resistance. Well, I maintain that the curves of the four ..., as the calculation have determined them, will give an impression of beauty because they will demonstrate to the viewer the boldness of the conception." Translated in Henri Loyrette, Gustave Eiffel, p. 176

613 Albert de Lapparent, Le Siècle de Fer, (Paris: Librairies F. Savy, 1890) pp. 95-96. Quoted in Frances Steiner, French Iron Architecture, p. 121

spéciale au métal, latente dans le métal, forme encore vague et indécise aujourd'hui, toutefois réelle et qui, se développant, doit nécessairement aboutir à de nouveaux types architecturaux.[614]

The 1889 Paris World Exposition clearly demonstrated the ineffectiveness of architectural rationalism in responding to the development of new material and technology, and the threat from engineers. Even their strategy to maintain their social role in technological culture with an aesthetic rationalism was proved not so effective. After the 1889 Exposition, therefore, reaction increased against modern technology and the rigor of scientific aesthetics, and the conservatism of architects grew. Huysmans, who had declared the emergence of a new modern style in iron architecture in 1878, also changed his opinion about iron in 1889. After criticizing the Eiffel tower, he concluded "le Fer," noting, "faute d'un homme de génie, le fer est encore incapable de créer une œuvre personelle entière, une véritable œuvre."[615] Dubech and D'espezel accurately described this changed situation when they wrote Histoire de Paris in 1926:

> Vers 1878, on crut trouver le salut dans l'architecture du fer: les aspirations verticales, la prédominance des vides sur les pleins et la légèreté de l'ossature apparente firent espérer que naîtrait un style en qui revivrait l'essentiel du génie gothique, rajeuni par un esprit et des matériaux neufs. Quand les ingénieurs eurent élevé la Galerie des Machines et la tour Eiffel en 1889, on désespéra de l'art du fer. Trop tôt peut-être.[616]

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614 A. Vierendeel, Architecture Métallique aux XIX Siècle et Exposition de 1889 à Paris, p. 8 and 14 . Quoted in Bertrand Lemoine, L'Architecture du Fer, p. 282

615 J. K. Huysmans first published this article in the Revue Indépendante in 1889. It was republished the same year under the title "*le Fer*" in his book of essays Certains (Paris, 1889). p. 181

616 Dubech et D'espezel, Histoire de Paris (1926) p. 464: "By the 1878, It was believed that salvation could be found in iron architecture; Its vertical aspiration.. the preference for over-filled spaces and the lightness of the visible skeleton fanned hopes in the birth of a style that would revive the essence of Gothic genius..."

Chapter Nine. Decline of Iron as a Signifier of Modernity: Transformation of Style Nouveau and Emergence of Reinforced Concrete, 1889-

> L'Exposition universalle of 1889, was a hymn to the glory of these rationalists, dominated by Formige's Beaux-Arts pavilion and Dutert's decoration of the Gallerie des machine... The triumph of the rationalist, in fact remained a cooperative affair, it was engineers who dominated profession fulfilling the prophesy of César Daly. And an engineer believed that he could do without the architect. When he did call him, he confined him to the role of a decorator- that of Stephen Sauvestre for Eiffel tower or Dutert for the Galerie des machines...The architect's response to the engineer's technical feat was quite inadequate. The counter project by Anatole Baudot which was an alternative to the Gallerie des machines was a kind of giant glass house. If architect followed the theoretical rules which they themselves had laid down, they were obliged to disappear as an architect. Industrial society may need scientists. It can easily do without artists.... the only way out of such an impasse was to give up technical rivalry with the engineers and thoroughly study the plastic working of form... Here the rationalist did admirable works.
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> Francois Loyer, Architecture of the Industrial Age, p. 188

Style Moderne of Iron: Triumph of Rationalism or the Ecole ?

Shortly after the 1889 Paris World Exposition, Frantz Jourdain, a Beaux-Arts trained architect, wrote an enthusiastic article on the iron buildings of the Exposition. In his article, originally published in Le Figaro and reproduced in La Construction Moderne, Jourdain claimed that the long awaited new modern style was finally born at the 1889 World Exposition: "On s'est longtemps plaint que le XIXe siècle n'eût pas de style personnel. Fondé jusqu'à un certain point, . . .ce reproche va,. . ., tomber aujourd'hui dans le vide."[617] The multiple and complicated problems raised during the construction of buildings for the World Exposition, Jourdain argued, necessitated giving up the outmoded aesthetics and empirical formulas inapplicable to the modern world. "A des besoins

617 F. Jourdain, "L'Architecture à l'Exposition Universelle," Construction Moderne (1888-1889), p. 469

nouveaux, des formes nouvelles." Instead of obstructing columns, thick masonry walls, and massive stone facades and domes, he wrote,

> . . . des armatures de fer laissent librement passer la lumière et l'art, des points d'appui élégants n'ayant que l'équarrisage mathématiquement nécessaire à la résistance et à la stablité des dômes audacieux, s'élevant, sans efforts, de 40 et de 50 mètres dans l'air, des portiques spacieux dont les supports graciles et largement espacés ne gênent ni la vue, ni la marche.[618]

Jourdain argued that in the iron buildings in the Champs de Mars, one should recognize that we had finally created a new monumental style of iron completely liberated from the influence of the historical Greek, Roman, Gothic, Renaissance or XVIIIth century styles: "La colonne et le pilastre, sans lesquels il semblait impossible d'avoir une façade monumentale, ont brusquement disparu. . . l'extérieur laisse deviner la destination de l'intérieur; ni plâtre ni brique ne dissimulent plus, sous un mensonger décor, le métal qui, vainqueur d'un préjugé imbécile, reçoit la consécration officielle de l'art monumental."[619] Among the Exposition buildings in the Champs de Mars, Jourdain singled out the Galerie des Machines by Dutert, along with the Eiffel tower, as the most honest example of such a modern style which threw away the past memories and classical precepts; with its fantastic span of 115 meters and the audacious creation of space, he wrote, it was "une œuvre d'art aussi pure, aussi originale, aussi élevée qu'un temple grec ou une cathédrale gothique."[620]

Unlike engineers and Republican critics who claimed the iron monuments of the Exposition mainly as engineers' achievements, however, Jourdain considered this architectural "revolution" at the 1889 Exposition as works of architects. Although

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618 Ibid., p.469-470
619 Ibid., p. 470
620 Ibid.

architects were caught up for a long time with classical doctrines of the École, new necessities," cette force aveugle and brutale," he argued, gradually obliged them to give up the outmoded aesthetic formulas and to create new forms. While Jourdain noted that the new forms of the Exposition buildings were created by architects trained in the École des Beaux-Arts, such as Dutert, Bouvard and Formigé, he nonetheless argued that they were created "malgré et contre" the École des Beaux-Arts. Their designs, he claimed, clearly showed a veritable protest against the official education of the Ecole and the architects' definite intention to free themselves from it; therefore, the new style was a triumph of the anti-Ecole principles, that is, of "architectural rationalism."

Jourdain was perhaps the only architect of the *Societé Centrale des Architectes* who hailed the iron buildings of the Exposition as a victory of "architectural rationalism." Although trained in the Ecole des Beaux-Arts, Jourdain was also strongly influenced by the Gothic rationalism of Viollet-le-Duc. In another article on the Exposition published in Revue des Arts Décoratifs,[621] Jourdain almost recapitulated the structural rationalist argument that decoration should not be separated from construction but a result of it and should express properly the material properties and its function.[622] Yet, he was a rationalist on his own feet. Thus, while admiring Viollet-le-Duc's structural rational principles, he also highly regarded Garnier's Opera as a model of rational architecture. Furthermore, he argued that architects should be raised again to the status of masters in all senses of the word, without a separation between constructors and artists.[623] And Jourdain believed that all these were finally achieved in the 1889 Exposition. At the 1867 Exposition, he wrote, "les ingénieurs s'etaient seuls aventurés et le chaudron de 1867 ne brillait pas précisément par les qualités artistques." At the 1878 World Exposition, the

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621 In 1889 Jourdain published a slightly different version of this article, "La Décoration et le Rationalisme, Architecture à l'Exposition Universelle," in Revue des Arts Décoratifs X (1889), pp. 33-38. This article was an almost same, but seemingly complementary version of his previous article.
622 See Jourdain, "L'Architecture à l'Expostion Universelle," La Construction Moderne, p. 470
623 See Jourdain, "La Décoration & le Rationalisme Architecturaux à L'Exposition Universelle," Revue des Arts Décoratifs (1889), pp. 33-38

architects became a little bit bolder and tried to embellish "de coups de crayon et de pinceau la maussade tôlerie de leurs frères enemies."[624] However, this time, architects were not satisfied with simply embellishing engineers' buildings, but produced "un admirable œuvre d'ensemble qui arrête et précise ainsi qu'un éclatant manifeste, des notions architecturales jusqu'ici vagues et confuses."[625] For Jourdain, the year 1889 was, thus, an awakening call to architecture; by putting an end to the sleep under which poor Art had degenerated, he argued, the triumph of rationalism would indicate to young architects the way henceforth to follow. He then wrote: "Il est temps que l'artiste reprenne le rang qu'il n'aurait jamais dû perdre, qu'il s'affirme en face de l'ingénieur menaçant et tant soit peu méprisant, qu'il se souvienne que l'architecte d'antan élevait des cathédrales et jetait des ponts, construisait des châteaux et fortifiait des places de guerre, décorait des maisons de ville et bâtissait des aqueducs."[626]

Obviously, there were idealistic and anachronistic aspects in Jourdain's assessment of the role of architects in the Exposition buildings and in his concept of architectural rationalism. First of all, it should be noted that, as discussed in the previous chapter, the rational structures of the Exposition buildings which Jourdain admired for having achieved a new aesthetic status were made possible by engineers through their rigor of scientific calculation while the role of architects was limited to the forms and decorations of the buildings. The regaining the traditional status of architects as master builders was not possible either since the division of labor in architectural production proceeded with the emergence of engineers and the development of modern science and technology. In an attempt to save the architect's role in the technological culture dominated by engineers, architectural rationalism had transformed itself into an aesthetic discourse; even this aesthetic view, however, could not be sustained when engineers created iron constructions,

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624 Jourdain, "L'Architecture à l'Expostion Universelle," La Construction Moderne, p. 470

625 Ibid.

626 Jourdain, "La décoration & le rationalisme, architecturaux à L'éxposition universelle," Revue des Arts Décoratifs (1889) p. 33-8,

claiming new aesthetics, as we have seen in the previous chapter. With an almost idealistic belief in the role of architect, Jourdain remained unambiguous in his rationalist arguments.

The ambiguity of Jourdain's rationalist position, however, was clearly manifest in his debates with other architects of the *Societé Centrale des Architectes* concerning the true root of the Exposition buildings. While architects of the *Societé* agreed that the iron buildings of the Exposition, such as the Galerie des Machines and the Pavilion des Beaux-Arts (fig. 128), created a new architecture, they regarded them, quite contrary to Jourdain, as the very product of Beaux-Arts education. For them, the new iron architecture was, thus, a "triumph of the Ecole" rather than that of rationalism.[627] The reasons for their claim were clear: most of the architects of the Exposition buildings, such as Dutert, Bouvard, Formigé, Sédille and Hermann, were students of the Ecole and the new formal and spatial ideas used in the Exposition buildings -- the axial plan, the use of iron construction for huge halls, domes and other formal motifs in the iron buildings--were what the architects had been practicing in the Ecole all along. Jourdain ridiculed their claim, questioning whether there was any formal similarity between the classical models such as the Greek temples and the Roman villas, and modern iron buildings such as the Galerie des Machines or the Eiffel tower; he asked rhetorically if any classical formula was applied to the Galerie des Machines and if its curious capitals were derived from the Classical five orders.[628]

The debates went on, and more architects participated. Among others, L.- C. Boileau came up with the clearest polemics. Responding to Jourdain, Boileau argued that it was wrong to see the Ecole only in the classical motifs such as entablature, columns and pilaster. He pointed out that there were courses for iron construction in the Ecole des Beaux-Arts.[629] Using his own heritage as the son of an iron builder as a foil, Boileau

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[627]For instance, see Roux, "Le triomphe de l'École," L'Architecture (1889)

[628] See Jourdain," L'Architecture (1889) pp. 337-339, pp. 349-363.

[629] Boileau, "L'Architecture à l'Exposition et les Projets de l'École des Beaux-Arts," L'Architecture (1889) p. 385

argued that students of old academicians were as good as himself in dealing with iron bars without entablature or pilasters.[630] When it comes to the calculation of iron structure, it was a completely different matter. For example, while the idea of *salle de machine* was originated from Dutert, its calculation belonged to engineers. Although the hinged structure used in the Gallery of Machines was conceived by the engineers of the Ecole Centrale, it was a pure construction, rather than architecture, that is, a means to materialize an architectural conception; it was Dutert who created a new form, using this structural invention. Boileau then finally touched the Achilles heel of Jourdain by bringing up the so-called structural rationalists' inability to calculate. As for the structural calculation, he argued, the structural rationalists were no better than the architects of the Ecole.

If the architect's role lay in forms and aesthetics, rather than in the calculation of structures, Boileau's argument was in fact legitimate. The ability of Ecole students to come up with a general *parti* of modern programs and to manipulate masses for artistic architecture were what brought the Exposition buildings into being. Then, it could certainly be argued that the iron Exposition buildings were the triumph of Beaux-Arts education, rather than of anti-Ecole rationalism. On the other hand, if what Jourdain admired as the essence of new modern style was rational structure derived from scientific calculation, then it was engineers who were responsible for this, rather than rationalist architects. Jourdain's rationalism, however, remained ambiguous between the engineers rational constructions and decorative formal aesthetics. Concluding his article, Boileau acutely pointed out this ambiguity in Jourdain's rationalism. He argued that Jourdain's rationalism was in fact, as Jourdain himself had expressed, not Gothic structural rationalism, but an ideal based on an illusion of rationalism on one hand, and prejudice against the Ecole on the other. He wrote: "il a réve d'un certain rationalisme extrêmement

[630] Boileau wrote: "Je suis élève de mon père. Cela veut dire que j'ai été élévé dans le gothique et, incidemment dans la construction en fer. J'avais dévoré avec enthousiasme le Dictionnaire de Viollet-le-Duc. losque j'eus l'idé, à vint-deux ans, de me présenter à l'école . . ." Boileau, "L'Architecture à l'Exposition et les Projets de l'Ecole des Beaux-art," L'Architecture, 8-17 (Aout, 1889) pp. 385-7.

libéral, et il veut croire envers et contre tous que ce rationalisme-là represénte les moyens de l'école officielle du mème nom."[631]

A year later, therefore, Jourdain qualified his position, clearly distinguishing the role of architects from engineers.[632] While maintaining his anti-Ecole, rationalist stance, he added that architecture should be distinguished by its attention to aesthetics. Although built of industrial material and using industrial technology, architecture is the result of the creative endeavor of artists, not mere calculation. Jourdain wrote:

> Qu'un ingénieur fasse de l'architecture, . . . ça n'a pas d'importance; il ne serait jamais l'artiste . . . L'ingénieur trouvera toujours que deux et deux font quatre; or, en art, il y a des cas ou deux et deux font cinq. . . . Il y aura assez de gens pour calculer la résistance d'une ferme, on ne trouvera pas toujours des artistes capables d'enfanter des chefs-œuvre semblables à ceux dont regorge notre riche patrie. . . Restons architectes et tâchons de devenir artistes, cela vaudra mieux! [633]

Commenting on the debates between Jourdain and the architects of the *Societé,* Anatole de Baudot, the leading architect of structural rationalism after Viollet-le-Duc's death, came in defense of Jourdain. In his articles examining the role of architects in the 1889 Exposition buildings, de Baudot refuted Boileau's assertion that Exposition constructions were the product of the Ecole education, arguing that the forms of iron galleries of the Exposition had nothing to do with Ecole education. The real question in iron buildings, he claimed, was not simply the ideas of forms but their materialization. He then pointed out that the iron buildings were materialized by engineers, rather than by architects of the Ecole. He wrote, "le système de forme qui a rendu réalisable la galerie des machines n'a pas été conçu à l'École. . . qui est d'ailleurs le résultat des tentatives faites par

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631 Ibid., p. 387
632 Jourdain, "Ingénieur," L'Architecture, (1890) pp. 446-447
633 Ibid., p. 446.

Polonceau. . . , Dion et par d'autres ingénieurs depuis cette époque; cette forme de fer est le résultat de la science et du calcul, et non pas une effort du génie humain."[634]

However, as is already clear, in defending Jourdain's position against Boileau's, de Baudot refuted Jourdain as well. That is, unlike Jourdain, Boileau regarded the iron constructions basically as works of engineers, with the role of architects being secondary as decorators. He wrote, "il [an architect] se contentait de décorer des ossatures" conceived by engineers and in the role "secondaire et regrettable, il ne se préoccupait pas assez des ressources que lui offraient les données nouvelles."[635] In de Baudot's opinion, Jourdain's real intention was to point out that the Exposition buildings did not result from Ecole education; however, taking up the issue, advocates of the Ecole simply claimed the opposite.[636]

Unlike Jourdain, de Baudot neither endorsed the iron constructions of the Exposition as a new style of modern architecture nor did he consider them as a victory of structural rationalism. Although they were rational constructions based on mathematical calculations, de Baudot criticized the Eiffel tower and the Gallery of Machines as lacking in artistic qualities:" . . . L'œuvre réelle d'architecture n'intervient en aucune façon, quoique la forme de ces deux immenses constructions soit à peu de chose près l'expression rationnelle de leur mode de structure."[637] Strangely enough, de Baudot brought up the classical aesthetic norms such as proportion and scale as grounds for their non-artistic qualities. He continued: ". . . lorsqu'on a imaginé un système quelconque de charpente en bois ou en fer, il ne suffit pas de l'appliquer brutalement, quelles que soient les dimensions adoptées, sans souci des proportions et de l'échelle."[638] While engineers of the iron

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634 De Baudot, "L'Architecte à L'Exposition Universelle de 1889," Encyclopédie d'Architecture (1889) p. 25-26

635 Ibid., p. 51

636 Ibid., p. 52. De Baudot wrote: "M. Frantz Jourdain, sans entrer dans la question de fond, a purement et simplement déclaré que cette galerie n'était pas le résultat des études faites à l'École, ce qui est absolument exact, et cependant les défenseurs de l'enseignement offciel l'ont pris à partie et sommé gracieusement de revenir sur cette déclaration. . ."

637 Ibid., p. 51. See also Paul Gaut, "Coup d'Œil Rationaliste sur l'Exposition Universelle," Encyclopédie d'Architecture (1889) p. 91-94

638 Ibid.

constructions were totally indifferent to proportions, he argued, architects of the Ecole were embarrassed when they were confronted with new iron buildings because their education was limited to the study of the proportion of the classical Orders.

As a result, the Eiffel tower, despite its height of 300 meters, created less effect of *grandeur* than Notre Dame. De Baudot argued that more than anything else, this was because of its improper scale and proportion. He also criticized the Gallery of Machines for the same reason. Of this, he wrote:

> . . .on n'y trouve pas davantage la conception vraiment architectonique et les qualités de proportions et d'échelle qui font la base de tout œuvre d'art. La première impression que produisait cet immense vaisseau. . . était assurément très imposante, mais le sentiment n'est que passager, et cet essai, qui est une fantasie sans avantages réels d'aucune sorte, a prouvé une fois de plus que l'effet de grandeur n'était pas le résultat de dimensions colossales mais celui de proportions bien entendues.[639]

According to de Baudot, the absence of columns in the hall space did not have a striking effect because, after their installation, one's gaze was interrupted by vertical objects on all sides. For the same reason, the longitudinal space, too, despite of its height of 60 meters and length of 400m, appeared encased and short.(fig. 129) He thus considered the Gallery as a hangar, rather than architectural art.

De Baudot insisted that his aesthetic judgment of these iron constructions was not based on the fact that they were created by engineers, but purely on their aesthetic qualities.[640] What he was interested in was not whether they were built by engineers or architects but whether the resultant buildings were in the domain of architecture or pure construction; while Jourdain and Boileau regarded the exposition buildings as architectural monuments, though for contrary reasons, de Baudot thought they were not. De Baudot maintained that an iron building could produce a monumental effect and could have artistic qualities while

[639] Ibid., p. 52

observing the rationalist principles such as material honesty and structural rationality. In this what he called "architectonic solution," he argued, "le parti général, l'ordomnance et les proportions forment la base de la conception."[640] For an artistic, or architectonic solution, de Baudot suggested adopting the system of a long span in the longitudinal direction as well. Then, "ce vaisseau eût dès lors perdu cet aspect de hangar qui ne peut-être nié, et en poursuivant rationellement l'application de l'idée fondamentale on eût trouvé une forme de coupoles qui, . . . eussent fourni une ordonnance vraiment originale, permettant de faire du nouveau . . . le sentiment de la proprotion et de l'échelle."[641] The result, he argued, would affect the exterior as well as the interior because it would permit to avoid "cette longue ligne de lourdre toiture qui. . . produit l'effet le plus triste, . ."[642] At the time of the Exposition, de Baudot in fact presented an alternative design for the Galerie des Machines as an example of an artistic solution, applying his theory. (figs. 130, 131) However, as François Loyer writes, it was neither rational nor artistic.[643] When considering that de Baudot revised his position even by introducing classical formal criteria, it seems clear that, despite his claim, his aesthetic judgment on iron architecture was not completely innocent of the architects' concern about their shrinking position in the construction of iron buildings.

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[640] Ibid.
[641] Ibid.
[642] Ibid.
[643] Francois Loyer, Recherche sur la Pensée et l'Œuvre d'Anatole de Baudot,1834-1915 (1973) p. 33. He wrote, "Le projet de Baudot, lourd dans son parti général, dans les proportions de certains de ses membres... est un faible exemple d'invention architecturale et technique. D'un point de vue plastique, sa démonstration ne convainc pas. Cet édifice massif où s'entremêlent le modèle Viollet-le-Ducien mais aussi des motifs inspirés directment de Dutert, en particulier les verrières, est sur le plan technique bien inférieur à la Galerie des machines. Aussi rationnel que soit le système de voûtement préconisé par Baudot, il n'est cependant rien moins que neuf. Il est moins hardi de faire franchier 115 metres à une.... Pour avoir voulu critiquer la méthode de tavail de l'ingénieur et souligner sa faiblesse rédhibitoire, Baudot fait la démonstration inverse et convainc malgré lui que les formules rationalistes strictement appliquées et l'historicisme en porte à faux constituent un frein pour la pensée crèatrice." p. 33

Transformation of *Style Nouveau*: from Rational Aesthetics to Decorative Interior

New forms, lines and decorations of iron constructions created in the 1889 Exposition buildings, whether done by engineers or architects, were considered a rational, monumental aesthetics of iron derived from material properties and the constructional principles. This rational concept of *style nouveau* that State officials, engineers and architects such as Jourdain glorified alike at the time of the 1889 Exposition, however, did not last long. By 1900, the concept of *style nouveau* had gone through a dramatic change. Rather than a rational aesthetics which reconciled industrial technology with artistic creativity, it came to signify anti-science, interior and individual fantasy, whose design motifs were derived from nature, and floral and female forms.

This changing concept of *style nouveau* from wrought iron monumentality to the decorative interior of Art Nouveau was made evident by the change in position of many critics and art directors, such as de Vogüé, Alfred Picard, Geroge Berger, Roger Marx, Eugene Hénard.[644] For example, Roger Marx, who glorified the Gallery of Machines in 1889 as the essence of new aesthetics, no longer praised iron architecture in 1900 as the essence of French modernity; rather he affirmed the feminine, interiorizing world of Loie Fuller and Art Nouveau. "The soaring grace of the latticed beams and glass panels of 1889 had given way to the soaring grace and fluidity of a woman dancer emulating a bird in flight-- Loië Fuller."[645] (fig. 132)

In explaining this sudden change of taste in Art Nouveau between 1889 and 1900, Debora Silverman argued that this taste for the decorative interior was a continuing aspect of French cultural modernity since the eighteenth century. Modern style had always been identified with a natural style; thus, it was not a transitory anti-modern sentiment against rationalism, an explosion of an organic craft interiority in Europe representing anti-modernism, or "the last gasp of romantic individualism, an ephemeral burst of creative

644 For an excellent summary of the change of Art Nouveau, see Debora Silverman, "Introduction: The Transformation of Art Nouveau, 1889-1990," Art Nouveau in Fin-de-Siècle: Politics, Psychology and Style, (Berkeley: Univ. of California Press, 1989) pp. 1-18

645 Ibid., p. 7

energy aiming to salvage individual artistic production from the standardized inventions of industrial aesthetics,"[646] as most scholars of Art Nouveau believed.

Silverman listed both long-term and short-term factors which affected this change between 1889 and 1900 such as deep-rooted French rococo tradition, on one hand, and aristocratic political atmosphere, the emergence of new woman, State marketing strategy and the development of Freudian psychology of the 1890s, on the other.[647] Although I agree with her that the anti-rational retreat to the psychic interior was an inherent aspect of cultural modernity and bourgeois rationality, I do not believe that Silverman explained why this shift occurred at this particular historical moment. Her explanation did not give a truly historical account of the driving forces behind this change, but only a phenomenal analysis of the political and socio-economical context in which this shift took place. Although this might explain the change of taste in interior design and craft arts, which was in fact the subject of the Silverman's research, it does not explain the change in the concept of Art Nouveau in architecture. In fact, Silverman herself admitted the insufficiency of her thesis in explaining the emergence of Art Nouveau in architecture, by pointing out the oddity of an Art Nouveau architect such as Hector Guimard. Furthermore, she never mentioned Franz Jourdain, a leading figure of French Art Nouveau architecture in his rate of architect. Therefore, I would like to argue that, in addition to Silverman's external factors, the change to Art Nouveau in architecture also arose from the internal contradictions of architectural rationalism, which I have analyzed so far.[648]

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646 Debora Silverman, Nature, Mobility and Neurology: The Ideological Origins of Art Nouveau in France, 1889-1890, (Ph.D. Dissertation, Princeton Univ., 1984) p. 9. This view of Art Nouveau was held most notably by Pevsner and Hitchcock. See Nicholas Pevsner, Pioneers of Modern Design from William Morris to Walter Gropius (London, 1975); Alfred Russell Hitchcock, Architecture: Nineteenth and Twentieth Century (1958)

647 See Debora Silverman, op. cit., pp. 10-12

648 The relationship between rationalism and Art nouveau in France had been pointed out by many scholars. However, there was no substantial inquiry into it and the descriptions about the relationship remained phenomenal. For example, see Francois Loyer, "Viollet-le-Duc to Tony Garnier,: the Passion for Rationalism" in Frank Russell, Art Nouveau Architecture (New York: Rizzoli, 1979) and Nikolaus Pevsner's above mentioned book.

Indeed, as we have seen, architectural rationalism had evolved greatly throughout the nineteenth century. Rationalist architects, who had once argued for the creation of a new style through the rational application of modern material and technology, had to secure the architect's role against engineers as iron construction emerged as a new style. By 1889, structural rationalists such as de Baudot even adopted the classical formal principles in an attempt to distinguish artistic architecture from industrial hangars, critically revising their earlier rationalist arguments. While distinguishing the role of architects from that of engineers, Jourdain, on the other hand, still believed that a new style could be created through the artists' intervention in the engineering structure. Jourdain's belief in the creation of *style nouveau* represented in a sense the last phase of the rationalist belief in an architect's ability to create rational, yet artistic forms and decorations beyond mere calculation, despite the dominance of industrial technology. However, the anonymity of modern industrial production and individual artistic creation were clearly at odds with each other. This contradiction was already grasped by many contemporary critics at the time of the 1889 World Exposition. With its mass produced standardized elements assembled by unskilled labor, modern technological rationality did not allow for the intervention of individual artistic creation. In 1889, a month after the Exposition, George Valbert pointed out this contradiction in his article "L'Age des Machines":

> Un artiste est un homme qui imprime à son travail la marque de sa personne, et produit un ouvrage qui diffère en quelque chose de ce que produisent les autres et dans lequel il se reconnaît. Autrefois, dans une certaine measure, tout ouvrier était un artiste ou peu s'en fallait. . . .
>
> Autrefois l'ouvrier était tenu d'avoir de l'industrie et de l'invention; aujourd'hui, des animaux étranges, bâtis en fer ou en acier, se chargent d'inventer pour lui. Quand on parcourt au Champ de Mars la merveilleuse galerie des machines, quand on se promène parmi ces monstres apprivoisés qui, grondant, hurlant, sifflant et crachant, accomplissent avec une violence méthodique des ouvrages d'exactitude et de précision, . . . , on éprouve pour elles un superstitieux respect et on admire les hommes de génie qui les

> ont inventées. Mais l'ouvrier qui les emploie est à leur service, et serviteur d'une machine, il devient un peu machine lui-même. Il doit faire toujours la même chose, se répéter sans cesse, mettre son honneur à tirer cent mille copies parfaitement identiques d'un modèle qu'il n'a pas inventé. Les machines sont des êtres impersonnels, qui condamnent à l'impersonnalité quiconque travaille par elles ou pour elles.[649]

The symbolist novelist Huysmans also criticized the Eiffel tower in 1889 in this respect. Huysmans had admired iron constructions as an indication of the advent of a new modern style in 1878. However, writing in 1889 at the time of the Exposition, he changed his position. The optimism he had in 1878 no longer existed. Despite the euphoric reception of the technological culture by the State officials and Republican critics, Huysmans criticized the Eiffel tower as lacking any trace of artistic genius:

> Cette allure d'échafaudage, cette attitude interrompue, assignées à un édifice maintenant complet révèlent un insens absolu de l'art. . . .
>
> Ici rien; aucune parure si timide qu'elle soit, aucun caprice, aucun vestige d'art. Quand on pénètre dans la tour, l'on se trouve en face d'un chaos de poutres, entrecroisées, rivées par des boulons, martelées de clous. . . L'on ne peut que lever les épaules devant cette apothéose de la pile de viaduc, du tablier de pont! [650]

Goncourt, who led the movement of French decorative arts, also criticized the Eiffel tower from an artistic point of view:

> La tour Eiffel me fait penser que les monuments en fer ne sont pas des monuments humains ou des monuments de la vieille humanité qui n'a connu pour la construction de ses logis que le bois ou la pierre. Puis, dans les

649 George Valbert, "L'Age des Machines," Revue des Deux-Mondes, xciii (juin 1, 1889) p. 692-693

650Huysmans, "Le fer," Certains (1889) pp. 175-178

this look of the scaffolding, this arrested attitude, in a now completed edifice, makes absolute nonsense of art. What, besides, is one to think of the iron worker who has his work daubed with Baredienne bronze, making it seem as if soaked in cold meat gravy?... On going inside the tower. You can confronted by a chaos of intersecting beams , riveted with bolts, hammered together with nails. You can only shrug your shoulders at this glory of wire and plate, at the apotheosis of the via duct pier, the bridge apron!.

monuments en fer les surfaces plates sont épouvantablement affreuses. Qu'on regarde la première plate-forme de la tour Eiffel, avec cette rangée de doubles guérites, on ne peut rêver quelque chose de plus laid pour l'œil d'un vieux civilisé.[651]

These criticisms of the aesthetic experience of the Eiffel tower were in fact a direct denial of the ideals of Republicans and their aesthetic model for a harmonious democratic society. While the aesthetics of iron advocated by the Republicans supposed the existence of creative, if not rational, individuals who were to make a harmonious whole, the aesthetics of iron construction experienced in the Eiffel tower denied or rather, undermined individuality with the structure's anonymity and insignificance, collectivity and conformity. As Valbert wrote, workers became a "serviteur d'une machine," and "un peu machine lui même." Thus, there was a discrepancy between the social harmonious relationships in production that these models promised and their appearance. Art was thus separated further from public life as was aesthetic experience from social activity.

According to Simmel and other German sociologists, as the rational, public modern technological world developed, the psychology of men or individual sentiment became irrational and retreated into the psychological interior and subjective fantasy.[652] The cultivation of a self was given a new life in its search for liberty in the interior of man. The development of the psychological category of interior, which Silverman argued has contributed to the redefinition of the concept of interior and thus, to the development of Art Nouveau, was therefore itself a reflection of the crisis of bourgeois rationalism. It was an attempt to salvage self from its fragmentation in the rationalization of society. This dialectic

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651 Goncourt, Journal, viii, 25, quoted in Hautecœur, Histoire de l'Architecture Classique en France, vol. 7, p. 410

652 This dialectic mechanism of modern life first theorized by German sociologist G. Simmel and further developed by theorists such as Lukacs, Benjamin and Adorno. However, before them, critics already sensed this psychologism even without theorization. See G. Simmel, "The Metropolis and Mental Life," in The Sociology of Georg Simmel, trans and ed. by Kult H. Wolff (New York: The Free Press, 1950)

nature of modern technology and the alienation of self were already pointed out in 1889 by George Valbert. He wrote :

> Ils seront encore plus surpris de voir que l'âge des machines avait plus de penchant que tout autre à exalter la personne humaine, et qu'a son insu et dans les meilleures intentions du monde, il travaillait à la diminuer. . . . le siècle des machines a vu se développer l'égotisme dans des proportions inconnues jusqu'ici. . . Aujourd'hui l'être le plus ordinaire, le plus banal, le plus insignifiant, de la plus mince étoffe, se fait un devoir et une joie de s'étudier, de se décrire, de se raconter sans nous faire grâce d'un détail, . . .
>
> Dans aucun temps, le moi n'a eu tant de prétentions, n'a tenu tant de place, ne s'est plus étalé, et pourtant tout contribue à gêner le libre développement des individus, à réduire la part d'eux-mêmes qu'ils mettent dans ce qu'ils font, à contrarier l'envie qu'ils pourraient avoir de se façonner à leur guise. La société où nous vivons nous aligne au cordeau, il n'a jamais été plus difficile d'être quelqu'un.[653]

If architectural form or decoration could not be derived from the rationality of construction or the intrinsic material properties, as discussed so far, architects had to adopt a formal language from other sources. Art Nouveau architects in fact drew plastic forms and decorations, from Gothic floral decorations and from nature, rather than from their principles. The architects were also obliged to retreat into self to compensate for the challenge to the individual by machines and technology. As a result, the rationalist effort to create a new form based on modern technology and material naturally led to individual expressionism. The retreat to individual decorative fantasy was thus, in a sense, a logical conclusion of architectural rationalism that dominated thinking of architectural avant-gardes

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653 George Valbert, op. cit., p. 691-692.
"It will hence surprise you that the age of machines has been inclined to exalt the human personality, while it appeared to be diminishing it. . .Egotism had developed to an unprecedented proportions in this century of the machines. Today, the most ordinary human being, the most banal, the most insignificant appoint himself to the joys of studying himself, of describing himself, of telling about himself.... in no other time has the self had so many pretensions, held so high a status, been so wide spread, and yet everything blocks the free development of the individual, reduces that part of himself he put into work, disappoints the yearnings he may have to shape himself according to his own way. The society in which we live aligns us in conformity, and it has never been more difficult to some body..

during the second half of the nineteenth century.[654] In this respect, it was not at all ironic that Viollet-le-Duc, a Gothic structural rationalist, was considered a precursor of Art Nouveau; it was his decorative designs, rather than his constructive systems, that influenced Art Nouveau. (fig. 133)

The introduction of *Art Nouveau* to Paris by an art dealer Siegfried Bing through his salon of Art Nouveau in 1895, where works of Belgian Art Nouveau architects such as Horta and Van de Velde were exhibited, should be understood in this French context of the crisis of architectural rationalism. Art Nouveau in Europe is considered to have started in 1892 with Victor Horta's Hotel Tassel.(fig.134) Horta and Belgian Art Nouveau artists were influenced by the Arts and Crafts movement of England, which began to exert its influence in Belgium after 1890. Horta also visited the 1889 Paris Exposition, where he was strongly inspired by the iron buildings. The Art Nouveau, like the Arts and Crafts movement, aimed to salvage the self by intervening into the industrial process and thus, by overcoming the alienation between art and industry. It also had a political connotation of popular democratic taste as opposed to the aristocratic taste of art; thus it was almost identified as an official socialist style at the time. However, unlike its British and Belgian counterparts, the Art Nouveau in France, introduced under the context that I have described above, was depoliticized and divested of critical social vision, and became a purely decorative movement.

By the end of the nineteenth century, Art Nouveau architects became a liberal profession like artists. Leaving behind the long tradition of ambiguous co-existence of an artist and a constructor, the architects became painter-architects. The designs and interiors of the Art Nouveau architects were exhibited by the same dealer in the same salon where the Post Impressionists held their exhibition. And the designs of the Art Nouveau

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654 The best article addressing the issue of the relationship between rationalism and Art Nouveau is Francois Loyer's short piece which appeared in <u>Architectural Association Quarterly</u>. Although he pointed out the contradictory nature of Art Nouveau in this respect, he did not yet see Art Nouveau as a dialectical consequence of rationalism. See Francois Loyer," Art Nouveau: Architectural principles" <u>AAQ</u> (1983) pp. 13-15.

architects such as Van de Velde, Sauvage, Hankar and Guimard were also spread through art magazines.

Art Nouveau was an aspect of modernity in that it was a continuation of a rationalist attempt to cope with the crisis that modern scientific rationality and the emergence of engineers brought about. However, the contradiction of Art Nouveau was that it sought to express the modern feeling through a language based on craft tradition in a world where the machine and modern science and technology dominate. As Eric Hobsbawm summarized well, "Art Nouveau was the culmination of this attempt to say the new in a version of the language of the old."[655]

The Demise of Iron as a Symbolic Material for Modern Architecture, 1900-

As *Style Nouveau* of iron lost its rationalist aesthetics to become a purely decorative movement, the belief in iron as the material for a new modern style of architecture inevitably began to fade. In 1896, Zola changed his mind about iron architecture. In his interview with Jourdain, Zola stated, "some years ago, I absolutely believed that a new material, iron would create the basis for a new and modern style... now it seems that we shall have to wait a long time for such a style."[656] In 1900, Vicomte de Vogûé repudiated his faith in a universalist technological civilization which he believed was prefigured in the Eiffel tower. He acknowledged that the promises of 1889 were not to be realized; rather than a "point of departure on an ever-ascending ladder," the iron architecture of 1889 was more like the culminating point of a descending curve." [657]

Certain critics blamed not only the excess of Art Nouveau but also the premises of rationalism from which French Art Nouveau originated. In 1900, Robert de la Sizeranne wrote an article entitled " L'Art a l'Exposition 1900- L'Esthétique du Fer." In this long

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655, Eric Hobsbawm, The Age of Empire, 1875-1914 (New York: Vintage Books, 1989) p. 232.
656 F. Jourdain, "Que Pensez-Vous de l'Architecture Moderne?" Revue des Arts Décoratifs, xvi (1896) p.95. Quoted in Debora Silverman, Art Nouveau in Fin-de-Siècle France, p. 7
657Cited in Roger Marx, L'Art Social (1913) p. 290. Quoted in Ibid.

article, he criticized the rationalists thesis that a new civilization would produce a new architectural style through the rational employment of iron, which is inevitably beautiful. De la Sizeranne argued instead that a rational construction is neutral, not necessarily beautiful. "Ce n'est pas le force du besoin qui est un principe de beauté. . . Là où le besoin se manifeste seul, il n'a le plus souvent ni laideur, ni beauté. Il y a une sorte de neutralité esthétique."[658] According to him, the idea of beauty was above all an aesthetic impression to eyes, neither an intellectual notion nor a utilitarian appropriateness. "Ce qui provoque d'abord l'admiration des yeux, ce n'est pas une notion intellectuelle, l'idée d l'appropriation à un usage, l'idée de signification structurale, ni même l'idée de stabilité: c'est l'élégance, le rythme, la silhouette totale, apparue."[659] Thus, although new concepts of structural stability that iron construction such as the *Galerie des Machines* brought into architecture, was completely acceptable to the eyes since the habit of solid support is not a permanent principle, iron was nonetheless a material for support, creating too much void and little surface.[660] Since the essence of architecture is solid rather than void, he argued, iron construction had always a major problem of filling the void. Iron could not create a new form by itself and thus, the question of new style was completely independent from the material of iron. For this reason, he criticized the architectural, monumental pretension of the iron construction at the 1889 Exposition, such as iron domes and the Eiffel tower, as inappropriate: "le grandes prétentions architecturales du fer en 1889 ont paru déplaisantes et que dix années passés à les considerer n'ont guère réconcilié personne avec elles. . . . Si l'on admet cette définition que les pleins sont les parties essentielles de l'architecture, il faut avouer que le fer fait bien mieux que de modifier l'architecture; il la supprime." [661] He continued, "admirable pour supporter quelque chose d'autre, il [iron] ne se manifeste point aux yeux par lui même. Le fer, dans l'art, est comme l'argent dans la vie: un bon serviteur,

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658 Robert de la Sizeranne, "L'Art à l'Exposition 1900- l'Esthétique du Fer," Revue des Deux Mondes (1er mai, 1900) p.188
659 Ibid., p. 180
660 He argued that "even the reversal of pyramid is not shocking. We did not doubt the stability of the gallery. The impression de elegance of the line, however, no longer changes." Ibid., p. 192
661 Ibid., 193

mais un mauvais maître."[662] What was important to him, then, was a decoration of surface, rather than a rational structure of iron. However, he was certainly not advocating Art Nouveau because he believed Art Nouveau went to extremes in its search for aesthetic pleasure. By creating architecture without real purposes and without useful forms, he believed, Art Nouveau artists could not find real beauty as well: "Il n'a cherché que le plaisir. . . . Pour avoir cherché seulement de nouveaux plaisirs, il est arrivé qu'on n'a pas trouvé de nouvelle beauté."[663] He then suggested, "on ne peut avoir le faîte sans les fondations. Il faut d'abord réaliser l'utile. On ne peut construire sur la beauté."[664] Yet, de la Sizeranne did not give a definite answer to how a new style could be created.

Anatole de Baudot was also critical of Art Nouveau. His rejection of Art Nouveau was grounded on his structural rationalist belief that decorative details whatsoever would not be necessary if, as he argued, "une ossature générale est elle même pourvue de qualités artistiques."[665] After his unsuccessful design of an alternative for the Gallery of Machines as an example of artistic architecture based on his principles, however, de Baudot finally came to the conclusion that iron was an inappropriate material for new architecture. In 1896, in an interview with de Villenoisy on the state of contemporary architecture, de Baudot said that he did not belive "que le fer soit l'élément constructif de l'avenir, en tant que matière principale et apparente, . . ." [666] However, rather than viewing a new style independent from material, like de la Sizeranne, de Baudot found the new material of reinforced concrete as a source for a new modern style. After meeting with Cottancin in 1892, a constructor who had just begun researching a system of reinforced concrete structure, de Baudot became interested in the material. He considered reinforced concrete

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662 Ibid. p.196
663 Ibid.
664 Ibid., p. 205
665 Anatole de Baudot, op. cit., pp. 51-53
666 de Villenoisy, "Architecture en Fer et L'Ecole Francaise Contemporaine," Revue des Arts Décoratifs, (1896) p. 279. Here, de Baudot brought up two reasons. He wrote: " Ainsi que l'avait dit M. Garnier, le plein et le mur sont des données impérieuses de l'architecture, et le fer n'y satisfait pas sans le secours de matières auxiliaires, pierre ou brique, qui viennent encombler les interstices; or, pour opérer leur liaison avec le fer apparent, on se heurte à d'insurmontables difficultés. Les joints ne sont jamais étanches, et les différences de dilatation travaillent sans cesse à les élargir." p. 280

a continuation of, or rather, a perfection of iron since he believed that it overcame iron's aesthetic weakness by providing iron solid masses of cement.[667] It was in this sense that he wrote in L'Architecture, La Passé, Le Présent, (1916): "Iron was merely the indication of the transformation, which was explained in full by its result, reinforced concrete."[668] De Baudot used reinforced concrete for the first time in 1893 for a Pavillion at Antony and in 1897 he built his famous reinforced concrete church of St.-Jean-de Montmartre.(fig.-135) After that, de Baudot proposed many designs of reinforced concrete halls, which appeared later. Clearly modeled after L.-A. Boileau's earlier designs of iron halls, his designs of reinforced concrete halls confirmed once again his perception of reinforced concrete as a continuation of iron construction. (figs. 136, 137)

Structural rationalists' turn to reinforced concrete, however, was quite a reversal of their earlier principle. While iron played the same structural role as cement in reinforced concrete, it was concealed within the thickness of cement. It was then self contradictory that the rationalists, such as Reynaud and Viollet-le-Duc, had criticized iron reinforced lintels of stone *voussoirs*, which used the same structural mechanics as reinforced concrete, of a dishonest use of the materials. Thus, structural rationalists' efforts to create a rational form based on material and technology ironically ended up with using iron as a reinforce material as in reinforced lintels. L.- C. Boileau, an enemy of the structural rationalist school for a long time, was quick to point out this irony in the rationalists' turn to reinforced concrete. Presumably referring to de Baudot, Boileau wrote in 1900:

> Quelques-uns, des maîtres incontestés, n'ont-ils pas ces temps-ci adopté le ciment armé? Est-ce que dans ce genre de construction, le fer ne joue pas, au point de vue de la résistance, un rôle égal à celui de ciment? Ces

667 Most of the architects interviewed in this article linked the fate of iron architecture with the development of reinforced concrete, primarily in aesthetic terms. They believed that reinforce concrete was a continuation of or a sort of iron construction which improved its aesthetic weakness. And it was for this reason that de Baudot insisted on naming it cement arme in his debate with Boileau.

668 De Baudot, L'Architecture, La Passé, Le Présent (1916) p. 171: "Le fer n'était qu'un acheminment vers une transformation, plus précise avec son dérivé le ciment armé, qui en possède tous les avantages, et vient combler avec une sûreté incontestable les lacunes profondies de l'emploi direct du métal."

messieurs le dissimulent. Pourquoi trouveraient-ils à redire à ce que d'autres se servent de pierre armée, en élevant dans l'espace avec l'aide du fer, des plates-bandes appareillées? C'est pourtant le même jeu, puisque le métal intérvient exactement de la même façon dans les deux cas, pour donner aux matières, ciment ou pierre, auxquelles on l'associe, sans le montrer, la qualité de résistance à la traction qui leur manque autant à l'une qu'à l'autre.[669]

L.- C. Boileau was also critical of the excessive individual expressionistic tendencies of Art Nouveau architecture. In his review of the 1900 Paris Exposition, he criticized Art Nouveau architecture for pursuing a "nouveauté pour nouveauté" and a "pure eccentricité," calling some of Art Nouveau buildings "architecture de rêve", or "architecture littéraire."[670] Without recognizing the intrinsic relationship between the burgeoning of excessive Art Nouveau and rationalism, Boileau nonetheless saw rationalism as a part of Art Nouveau tendencies. However, in this regard, Boileau provided a fairly interesting account of the problems with rationalism. He acknowledged the positive role played by Gothic rationalism against the Academy in providing the "valuable principle" that each material should be treated according to its intrinsic properties: "Les novateurs de l'école gothique ont . . .prêché le retour au bon sens des arts décoratifs, et ils ont obtenu des résultats précieux,"[671] However, he argued that the rationalist principle could be applied only to the decoration of two dimensional objects; for the decorations of three dimensional structures, one had to consider not only the material properties but also the mode of assemblage and the process of fabrication. The rationalists often confused "la menuiserie" with "la petite charpente," and, in short, envisaged "les moyens modernes si complexes à un point de vue toujours très simpliste."[672] For him, an iron structure, completely

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669 Louis-Charles Boileau, "L'Art Nouveau," L'Architecture (1900)
670 Louis-Charles Boileau, "Causerie: L'Art Nouveau à l'Exposition de 1900," L'Architecture XIII, no. 51, (Dec. 1900) pp. 429-435
671 Ibid., p. 430
672 Ibid.

determined by calculation, could not make an artistic form; the iron skeleton should be enveloped as our bones are enveloped by muscle and skin, and this is what constituts the norms of plastic beauty. Thus, Boileau stressed once again his principle that iron is a simple means for architecture: " En principe, . . je considère le *fer de construction* comme un simple moyen. Que ce fer serve de renfort, ou qu'il remplisse la fonction d'une ossature essentielle, je ne tiens pas plus à son apparence que, par exemple, à celle des chaînages que l'on noie dans l'épaisseur des murs en maçonnerie."[673] Instead of individual fantasy or strict rationalism, what Boileau argued for was "le rajeunissement des choses par des simples nuances."[674] He wrote in conclusion: "La nuance du style que nous sommes en droit d'attendre de l'art nouveau se déterminera dans des formes viables, si nos confrères les artistes novateurs de ce temps veulent bien s'efforcer d'être aussi sincères et aussi consciencieux, dans leurs études, . ."[675]

By 1900, thus, neither structural rationalists nor classical rationalists favored iron construction. As de la Sizeranne wrote, ". . . depuis dix ans, le mouvement en faveur du fer apparent semble arrêté net, et qu'à certains de ces monuments, on n'a encore trouvé ni leur emploi, ni même leur couleur."[676] Frantz Jourdain, who was a major promoter of the *Style Nouveau* of iron since 1889, himself wrote in 1900: "Si l'on compare l'admirable effort de 1889, effort de jeunesse, de vitalité, d'audace, de rationalisme, de confiance en l'avenir, avec les piteux plagiats et les maladroits récopiages de 1900, on est contraint de reconnaître qu'un vent de réaction brûle et dessèche notre malheureux pays." [677] He also wrote in 1900:

> A l'exposition universelle de 1889, un sincère mouvement vers la vérité s'était manifesté, et on avait héroiquement cherché à se débarrasser des oripeaux du mardi gras dont nous étions affublés. Les palais des Beaux

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673 Louis-Charles Boileau, "L'Art Nouveau," L'Architecture (1900)
674 Ibid., p. 430
675 Ibid., p. 435
676 Robert de la Sizeranne, op. cit., p. 191
677 F. Jourdain, "L'Architecture à l'Exposition Universelle," Revue des Arts Décoratifs (1900) p. 245

-Arts et surtout la Galerie des Machines, cette cathédrales moderne, avaient loyalement montré le parti que on pouvait tirer du fer et de la terre cuite: malheureusement, ce bel élan n'a pas duré. . . En 1900, le faux et le toc triomphent sur toute la ligne, à de trop rares exceptions près.[678]

Jourdain, however, was still optimistic about the future of iron architecture. Writing in 1900, he maintained his belief in rationalism. His logic was this: the pessimistic reflection on the art nouveau concerned only the "aesthetic side" of contemporary architecture. From the material point of view, advances in science and technology were inevitably used even in most conservative architecture. Thus, the problem was only that these scientific discoveries simply did not yet influence architectural forms. Jourdain then argued that the future of architecture would depend on whether the partisans of modern architecture continued their efforts.[679] But his argument was a simple repetition of naive rationalist belief. As we have seen, rationalists had been struggling with this aesthetic problem of finding forms befitting modern science and technology for decades, only to arrive at individual expressions of Art Nouveau decorations.

Unlike structural rationalists, classical rationalists, on the other hand, separated aesthetics and technology. In his Éléments et Théorie de l'Architecture published in 1902 as an exhaustive compilation of the Third Republic École education, Julien Guadet, the professor of Theory at the École des Beaux-Arts, continued to emphasize the mastery of techniques, modern scientific discovery, details and good drawing in architecture, while maintaining classical formal principles. It could be argued that given the difficulties which rationalists faced in creating a new viable formal aesthetics, his insistence on the classical formal norms was more realistic.

After 1900, as a reaction to exuberant decoration of Art Nouveau, classical taste gradually became dominant. The year 1903 was a critical point in this shift of taste from

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678 Frantz Jourdain, "Les Conquêtes de la Science-Architecture," L'Architecture (1900) pp. 378-379
679 See ibid., p.379

Art Nouveau to the classical modernism.[680] By 1910, architectural taste clearly shifted toward simpler, more cleanly defined cubical forms.[681] However, after the decline of Art Nouveau, architectural discourse on iron as a new material for modernity disappeared. Instead, with the emergence of classical taste, reinforced concrete, which had been used in structural rationalism by de Baudot and in Art Nouveau taste by Auguste Perret, began to be regarded as a more rational material; while iron was associated with the Gothic from its inception, reinforced concrete was thus gradually linked to Classicism. This shift in the material signifier of modernity in architecture proved that, unlike the long-held belief of rationalist architects and theorists, architectural discourses on modernity had nothing to do with material and technology after all; while the development of modern materials and technology no doubt fundamentally transformed the disciplines of architecture, it was aesthetics that mattered in architectural discourses.

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680 Critical responses to Guimard's metro, built in 1903, exemplifed this. See Parel Planat, "L'Art Nouveau Appliqué aux Chemins de fer," Construction Moderne XIX (1904) pp.1-4 and also " L"Art Nouveau et Modern style," Construction Moderne XIX (1904) pp.397-400

681 Frantz Jourdain's Samaritine department store which started in 1900 at the hey day of Art Nouveau and was completed in 1907, was the last monument to iron architecture in Art Nouveau taste. When it was completed, Art Nouveau was already in decline. When it was completed, Fortuny criticized Jourdain's Samartine as not being rational despite his militant action,: "C'etait pas une oeuvre de raison mais une architecture véhémente, où le fer, capricieux et fantasque, improvise des escalades, parfois amusantes à la vue... Ils sont le geste, fixé pour l'avenir, d'un protestataire écoeuré de trop de veuleries de trop de néant, et qui, traitant le vaste thème, si actuel, d'un grand magasin, a voulu, d'un coup, un élan d'ambition chevalestique et peut être sûr de la défait, foncer sur "L'ennemi imbécile", lui montrer ce que c'est d'oser, en faisant résolument autre chose, en se séparant de tout et de tous... son manifeste de fer est un credo schismatique, conçu dans le lyrisme par une âme en révolte. Pascal, "Dix Annees d'Architecture," Gazette des Beaux-Arts (1910) 433-4,

Conclusion: Iron Construction, and Histories and Ideologies of Modern Architecture

> The growing proletarianization of modern man and the increasing formation of masses are two aspects of the same process. Fascism attempts to organize the newly created proletarian masses without affecting the property structure which the masses strive to eliminate. Fascism sees its salvation in giving masses not their right, but instead a chance to express themselves. The masses have a right to change the property relations. Fascism seeks to give them an expression while reserving property. The logical result of Fascism is the introduction of aesthetics into politics.
>
> Walter Benjamin, in "The Work of Art in the Age of Mechanical Reproduction" (1936)

Histories of Modern Architecture and Myth of Nineteenth Century Iron Construction

It was by modernist historians of the late 1920s and early 30s, such as Sigfried Giedion, Roger Ginsburg, Gustav Platz, and later Nikolaus Pevsner, that nineteenth century French iron construction was rediscovered as a determining factor of modern architecture. The rediscovery of iron construction was motivated by the modernist historians' purpose to construct a history of modern architecture relying on a rationalist, constructive tradition. By the late 1920s, the so-called new architecture with flat roofs and unembellished cubic forms, which emerged oscillating between the modern building technology and modernist avant garde aesthetics, appeared as a new style of the modern age across Europe. With the technological utopian metaphor, the new architecture already won the battle against the traditionalists in productions as well as polemics.[682] While largely concerned with searching for a new aesthetic form for the modern age, modernist architects saw in the

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682 The 1927 Weissenhof Siedlung was the pivotal moment of this new architectural movement. For a detailed account of the Weissenhof Siedlung, see Richard Pommer and Christian F. Otto, Weissenhof 1927 and the Modern Movement in Architecture. (Chicago: Univ. of Chicago Press) 1991.

unornamented geometric forms of reinforced concrete buildings the real possibility of the unity of new aesthetics and modern building technology. Therefore, they promoted their architecture as an achievement of a synthesis of art and technology and thus, a unified style of the modern age, which embodied the modern spirit.[683]

In attempts to secure the triumph of the new architecture, on the one hand, the modernist architects emphasized the decisive break of the forms of their architecture with past styles. That is, their form was a logical consequence of the new material and construction technology, and the rationalization of the building industry; no part of the form came from past artistic tastes. On the other hand, modernist historians made attempts to construct a historical legitimacy of the new architecture, trying to root the new architecture of the 1920s in a tradition; not in its usual terms, but in the constructive rationalist tradition of the nineteenth century. They then rediscovered nineteenth century French iron construction, the most conspicuous material signifier of modernity of the nineteenth century, as a precursor of modern architecture. While the material of the new architecture of the 1920s was reinforced concrete, they argued that the constructive tradition was maintained in iron constructions during the nineteenth century.

Books on the history of modern architecture began to be published in 1927, when Gustav Platz published the Die Baukunst der neuesten Zeit, in which he suggested that nineteenth century engineering construction was the first honest architecture since the end of the classical age in the eighteenth century. One year later, Giedion published Bauen in Frankreich: Bauen in Eisen, Bauen in Eisenbeton, where he for the first time connected French iron construction to the new architecture of the 1920s, offering the basic idea of the relationship between industrialization and architectural form. The ideas in this book were later elaborated in Space, Time and Architecture (1941), which became a classical text of modern architecture for several decades thereafter. In 1930 Roger Ginsburg published Frankreich of the series of *Neues Bauen in der Welt*, tracing the constructive and

683 Walter Gropius first published International Architecture in 1925

functionalist tradition in French architecture from iron constructions to reinforced concrete buildings.[684]

While other historians focused on the technological and constructive rationality of the new constructions, Giedion was interested in their architectural expression. He considered nineteenth century French iron construction a great architectural achievement, where new material and construction technology became a new architectural expression. As Giedion writes in his Bauen in Frankreich, "Construction becomes Expression," and "Construction becomes Form."[685] However, according to Giedion, the iron construction remained subconscious during the nineteenth century century because the nineteenth century, engrossed in the taste of past styles, did not have adequate principles to experience and to express it. The decorative elements which remained in iron constructions were an evidence of this. The aesthetic possibilities of new material and construction was fully realized in the unornamented flat surfaced reinforced concrete architecture of the 1920s.

In his book, Giedion specifically suggested common aesthetic qualities of nineteenth century iron construction and the reinforced concrete architecture of the 1920s: subjective aesthetic experience of the buildings, such as relations and interpenetrations without solid boundaries. Obviously, these aesthetic principles were developed by modernist avant garde paintings, such as Cubism and Neoplasticism, and had been applied to reinforced concrete architecture by some modernist architects such as Le Corbusier. Applying these aesthetic princples, experienced by modern man wandering about the building equipped with a visual apparatus informed by the modernist painting, to iron constructions, Giedion rediscovered the aesthetic quality of nineteenth century iron construction, connecting it to the reinforced concrete architecture of the 1920s.

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684 The first popular and comprehensive history of modern architecture, however, was Pevsner's Pioneers of Modern Design published in 1936, which gave the first comprehensive genealogy of modern architecture of the 1920s from the historical standpoint.

685 Giedion, Bauen in Frankreich: Bauen in Eisen, Bauen in Eisenbeton, translated by Duncan Berry as Building in France, Building in Iron, Building in Ferro-Concrete (Santa Monica: The Getty Center for the History of Art and the Humanities, 1995) P. 142.

The genealogy of modern architecture was fully developed later in the histories of modern architecture by Pevsner and Giedion. Despite differences in specific details, the basic narrative structure of the modernist historians was almost the same. They began their stories with the fundamental rupture and crisis of nineteenth century culture brought about by the development of modern technology and industrialism--the separation of technology and art, of engineering and architecture, and of thinking and feeling. While modern technology dominated everyday life, art lagged behind modern technological progress and was alienated from everyday life. This cultural crisis of the nineteenth century was finally overcome by the modern architecture of the 1920s which they argued reintegrated art and technology, and thinking and feeling. For Pevsner, this process of synthesis was marked by the works of modern pioneers, such as Behrens and Gropius, who introduced a new aesthetic sensitivity into nineteenth century engineering construction. For Giedion, it was achieved by anonymous development of modern construction, in which fundamental aesthetic principles governing both the objective world and subjective psyche simultaneously, such as the space-time concept and transparency, were realized. Both authors rationalized modern architecture's synthesis of art and technology as a necessary realization of the *Zeitgeist* of the modern age.

However, as already seems obvious, Giedion's rediscovery of the aesthetics of iron fundamentally misrepresented nineteenth century architecture. First of all, iron construction was not considered as a new architectural expression or as a synthesis of art and technology. Giedion claimed that the aesthetics of iron construction lay in the interrelations and penetration without solid boundaries, aestheticizing industrial objects. However, as we have seen in Huysmans' critique of the Eiffel tower in 1889, the iron construction was criticized by the critics during the nineteenth century for the formal aesthetics with which Giedion appreciated it. How did iron construction, which had been considered aesthetically weak, suddenly become an aesthetic object in a decade? How can one explain this complete reversal? In fact, for that matter, reinforced concrete was not an exception either. Originally, reinforced concrete was not conceived by rationalist architects as a material for the new modernist aesthetics that Giedion suggested. After dropping iron as an inappropriate material for an architectural expression, the rationalists considered reinforced concrete as overcoming the aesthetic weakness of iron. Thus, reinforced concrete was conceived as a material appropriate for the rational expression of a structural logic, rather than for the aesthetics of penetration and interrelations. De Baudot and Perret's use of reinforced concrete in their projects clearly testifies to their structural rationalism.(fig.138) The association of iron and reinforced concrete architecture with modernist avant garde aesthetics was then a pure aesthetic invention of the materials and construction rather than the revelation of their inherent characteristics as Giedion claimed.

After all, paradoxical as it may seem, it was only after the invention of the modernist avant gardes, such as Cubism and Purism and their new aesthetic principles, rather than the creation of a new style of iron architecture, that architecture was finally reconciled with modern technology. But the reconciliation was achieved only at the level of subjective consciousness.

The synthesis of technology and art that the modernists claimed to have been resolved by the architecture of the twenties was then far from what the nineteenth century structural rationalists sought to achieve. For the nineteenth century rationalists, the unification of art and science meant the creation of either a new system of construction or a system of comprehensive knowledge, as Reynaud, Viollet-le-Duc, and Daly had theorized. While nineteenth century rationalism was based on such concepts as honest structural expression (e.g., *pan de fer*) or an aesthetic form of constructive system, for the modernist historians, the reunification of architecture and engineering was a subjective psychic reconciliation with technological forms. Seen from this standpoint, Giedion's rather strange connection of iron construction and reinforced concrete buildings made between the Bauhaus and the 1878 Exposition building, a building which was much praised as expression of structural rationality at that time, perhaps could be better understood.(fig.139) Consequently, the continuity of constructive tradition between nineteenth century iron construction and the new architecture of the 1920s that the modernist historians argued was pure invention, rather than a historical fact.

If it was a new aesthetics, rather than a new system of construction, that the modern architects and historians came up with, then the rupture between nineteenth century architecture and modernism that modernists claimed does not seem as radical as the historians suggested either. As we have seen, the attempt to find new aesthetic principles befitting modern science and technology had been continuously made throughout the second half of the nineteenth century. The only difference was the new avant garde aesthetics and modernist abstraction that broke away from the traditional aesthetic principles. However, the modernist aesthetic was also an aesthetics. Thus, the decisive break of the new architecture with the nineteenth century eclectic tradition that modernists claimed was not substantial either.

Critique of Modernist Historiography

The histories of modern architecture by the modernist historians were criticized by many post World War critics especially because of their notorious selectivity and partiality. The critics demonstrated that the simplistic historical trajectory of the modern architecture that the modernist historians established was rather fictional. They revealed that the modern movements were not monolithic, but there were many diverse and even contradictory tendencies within the modern movements that had been omitted in the histories of modern architecture. The blame for the selectivity was put largely on the modernist historians' technological bias. The modernist historians' desire to establish the direct connection between modern technology and modern architecture was considered to have led them to exclude all irrational and anti-technological aspects within the modern movements, such as Art Nouveau and Expressionism, regarding them as an ad hoc or transitory factor. The modernist historians claim for the technological objectivity of modern architecture was also challenged by post World War critics. In his Theory and Design in the First Machine Age (1960), Reyner Banham pointed out that contrary to the claim of the modernist historians, what the modern movements of the 1920s achieved was an abstract, aesthetic architecture, lacking technological and material bases. Claiming that the re-integration of art and technology by modern architecture was only at the level of image,[686] he argued for true functional, technological modern architecture. While reinterpreting modern architecture's relationship to modern technology and industrialization, other critics such as William Jordy focused on the symbolic and spiritual relationship between the two.[687]

In the criticisms, however, the terms of modernist histories remained fundamentally unquestioned and the myth of modern architecture survived. That is, the critics shared with the modernist historians the belief that modern architecture was to be a unified style of harmonious modern culture, embodying the "spirit" of the modern age, and that the ultimate reference for modern architecture was, whether objectively or symbolically, modern technology and industry. Although diverse tendencies within modern movements were found, the plot line of the modernist histories was maintained without a fundamental change; it is "only enriched with accessory elements and aspects; the pioneers multiply; secondary figures proliferate; the new tradition takes on more facets and complexity."[688]

Thus, despite the criticisms, what I would call the ideological structure of the modernist histories was not revealed. Key terms here are technology and its relationship to architecture. My argument is that the modernist historians not only fabricated the myth of modern architecture and its technological objectivity through their selective and partial construction of history, but also mystified the term technology and its relation to

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686 See Reyner Banham, Theory and Design in the First Machine Age, (London, 1960) Banham cited the projects of Buckminster Fuller as a truly technological modern architecture. For a critique of Banham, see William H. Jordy, "Symbolic Essence of Modern European Architecture of the Twenties and its Continuing Influence," JSAH, Vol. 22 (1963): pp. 177-187

687 See William H. Jordy, Ibid. A recent historian, William Curtis, also wrote in his Modern Architecture Since 1900 that "modern architects sought a kind of poetry of everyday facts transcended by ideas."

688 Vittirio Magnango Lampugnani, "A History of the Histories of Architecture of the Twentieth Century, Rassegna, 25 (1981): last page of English translation.

architecture and thus, as I will discuss later, paradoxically paved a way for the abstracted and subjective notion of architecture.

In fact, the modernist historians were the first who focused on the relation of modern technology and industry to architecture. While the modern architectural movements developed in direct response to the changing conditions of a technological and industrial society, historians of art and architecture up until the early twentieth century paradoxically had developed purely formal and idealist aesthetics and histories detached from the material bases of artistic production.[689] Based on the idealism of Kant and Hegel, traditional historians sought to explain the change of artistic forms and styles purely in terms of an autonomous history of vision or formal principles.[690] Although historians of the turn of the century advanced a more objective stance towards artistic phenomena by means of scientific analysis of the structure of vision and perception, and they influenced the development of modernist painting's linguistic revolution to some extent, aspects of the technological and functional art and architecture that emerged in close relation to modern technology and industrialism remained incomprehensible because of their traditional concepts of art and artistic production. Consequently, they either avoided the issue of contemporary artistic and architectural development as something irrelevant to their study, or they had trouble explaining the emergence of modern art and architecture in a consistent way.[691]

The modernist historians, though rooted in traditional history, were deeply engaged in contemporary artistic and architectural movements to distance themselves from the present, and took as their primary task the legitimization of the then prevailing new architecture from a historical standpoint. Unlike traditional historians, the modernist

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689 This paradoxical situation was discussed by Paul Zucker in his "The Paradox of Architectural Theories at the Beginning of the Modern Movement," JSAH, vol. 10, no. 3 (1951).

690 The development of formalist aesthetics itself was a product of the modern technological society. See Francesco Dal Co, Figures of Architecture and Thought: 1890-1920. (New York: Rizzoli, 1990) especially Chapter. 2, Project, Words, Things," and also Ignasi Sola-Morales, "Towards a Modern Museum: From Riegle to Giedion," in Oppositions 25 (1982)

691 For an example, see Paul Frankl, Principles of Architectural History: The Four Phases of Architectural Style 1420-1908 (Cambridge: MIT Press, 1968) Originally published in 1914.

historians recognized modern technology as an essential factor in the development of modern architecture.[692] They thought that the development of new materials and technology categorically changed the norms of architectural styles, and that traditional histories were not capable of understanding the new norms because of their old fashioned concepts. The new architecture of the early twentieth century, then, though lacking any reference to historical styles, was neither totally ahistorical, nor did it mark the end of style as the critics of modern architecture had argued; it was a new style of the modern age.

However, the concept of technology in modernist architectural histories lacked its historical specificity of modern technology and its larger social implications. Without addressing the historical and dialectical nature of modern technology and its relation to architecture, it was treated simply as a new form of construction and in terms of its impression on viewers; thus, the relationship between architecture and technology became purely formal and iconographic-- a machine aesthetics or an aesthetics of functionalism, so to speak.

However, as discussed in previous chapters, the relationship between technology and architecture was more fundamental than this. The modernist historians attempt to see the concept of technology in architecture as something formal, as stone or iron construction might have indicated. However, as the decline of iron as a material for a new modern style historically proved, there was no intrinsic relationship between technology and form; nor does technology create a new style on its own. The construction process in architecture is never homogeneous; it includes not only different kinds of materials and construction techniques, but also different kinds of labor and professions. Thus, technology in architecture inevitably involves organizing principles of technical activities in the process of construction, which inevitably involve social relations. Recognizing this social implication

692 For a discussion of the paradoxical meeting between an ahistorical avant-garde position and the modernist historians, see Spiro Kostof, "Architecture, You and Him: The Mask of Sigfried Giedion," Dadaelus. vol. 105, no. 1 (Winter, 1976): pp. 194-195

of modern technology, Herbert Marcuse defined technology as a "social process" in his essay, "Some Social Implications of the Modern Technology":

> Technology is taken as a social process in which technics proper is but a partial factor. We do not ask for the influence or effect of technology on the human individuals. For they are themselves an integral part and factor of technology. Technology as a mode of production, as the totality of instruments, devices and contrivances which characterize the machine age, is thus at the same time a mode of organizing social relationships, a manifestation of prevalent thought and behavior patterns, an instrument for control and domination.[693]

Thus, the relationship between technology and architecture is not simply a matter of the aesthetic effect of the technological object and constructive form, or representation of technology, but of the technology inherent in architectural design and the process of construction. In the fields of art and culture, critical theorists such as Walter Benjamin and Theodor Adorno had already developed a theory of modern art based on the dialectical materialist analysis of the relationship between modern technology and of art. Although the two theorists differed regarding the specific way in which the social mode of production was mediated in artistic technology, they both clearly showed how the concept of art itself, along with its mode of production and reception, had been categorically changed in relation to the transformation in the technological mode of production.[694] The mediation between technology in architecture and technology in the social mode of production seems even more direct than in any of the other arts. Because of the collective and wide-ranging process of production, architecture is intrinsically connected to the social relations in the

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693 Herbert Marcuse, "Some Social Implications of Modern Technology," The Essential Frankfurt School Reader, ed. Arato (New York: Continuum, 1987) p.139.

694 Whereas Benjamin saw a direct connection between technology in artistic production and the social mode of production, Adorno clearly distinguished artistic techniques from the latter. On the discrepancy between them, see Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in Illuminations (New York, 1978) and Adorno, "Letter to Benjamin" in Aesthetics and Politics (London: New Left Books, 1977)

technological mode of production, which makes the relationship between the development of modern technology and of architecture a very complicated historical dialectic.

In fact, as discussed in the previous chapters, the separation between technology and art, between thinking and feeling, with which modernist historians began their historical narratives, was itself a historical product of the dialectic process of the development of modern technology. Ever since the late seventeenth century, the development of modern science separated factual truth based on objective rational principles from subjective artistic intention. Technology therefore became a material means to realize objective scientific principles, contradicting the classical norms of architecture. Despite the contradiction between modern technological means and traditional formal norms, which was already recognized by Perrault, the formal norms of architecture were nonetheless maintained under Neoclassicism. However, this compromise was a fragile one, and it finally exploded. The discipline of architecture, which was valued precisely because of the organic unity between art and technology, then had to undergo a radical process of redefinition between the art of design and the science of building. Since then, the creation of a new style of modern architecture by the integration of modern technology into architecture was an ideological dream of rationalist architects. In this context, iron in particular, emerged as a material agency to create a new style. Claiming its superiority over engineers in the aesthetic domain, architects tried to create a new artistic style by integrating aesthetics into iron construction. However, as analyzed in this dissertation, the rationalists' attempts to create a new style by integrating technology and art did not succeed in the categorical separation between the two. Architects' attempts to endow iron construction with an aesthetic quality was reduced to individual fantasies. Or, attempts to find the aesthetics of iron construction ended with the ultimate endorsement of engineering construction, which threatened the role of architects in society. Faced with this dilemma of rationalism, on the one hand, rationalists changed the material signifier of modern architecture from iron to reinforced concrete. On the other hand, architecture became more and more an artistic discipline, abstracted from the material and technological base, which were left to engineers. Thus, the development of modern technology brought about a fundamental problem of fragmented modern culture between technology and form. The transformation of architectural discourses on iron construction ultimately corresponds to the process of the disciplinary formation of modern architecture: the formalization and the aestheticization of architectural discipline in the process of mechanization and "technologization."

In fact, the modernist historians, in addressing the relationship between modern technology and modern architecture, rightly grasped the fragmented condition of modernity brought about by the development of modern technology and rationalization, and as discussed earlier, made it a starting point for their histories. Their analysis of the fragmentation of modern culture was not unlike that of the critical sociologists of the early twentieth century like Georg Simmel and Georg Lukacs, who initiated the dialectical materialist analysis of modern culture a decade earlier. Giedion's analysis of both the subjective and objective conditions of modernity especially corresponded to the concept of the reification developed by Lukacs.[695]

However, the modernist historians did not maintain this dialectic materialist position,[696] and easily presumed the synthesis of the fragmentation of modern culture by relying upon the metaphysical principles of idealism. For that matter, the modernist histories seem heavily based on the Hegelian concept of totality of culture, which is secured by an autonomous movement of history itself. According to this idea, the movement of history as an autonomous process tends to reconcile all its contradictions within itself, forming a historical totality of culture. Thus, it is a historical necessity to form a unified

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695 See Georg Lukacs, "Reification and the Consciousness of the Proletariat," in History and Class Consciousness (Cambridge: MIT Press, 1968): p. 83-109

696 Kenneth Frampton, "Giedion in America: Reflection in a Mirror," in On the Methodology of Architectural History," London, Architectural Design (1981)

culture of the modern age, in which art and architecture play the role of a privileged medium representing the cultural unity.

It is at this point that modernist history shows a methodological inconsistency on the matter of modern technology.[697] In other words, the modernist historians did not apply the same concept of modern technology employed in the analysis of modern culture consistently within the architectural mode of production. As discussed earlier, the concept of architecture as an aesthetic practice separated from technology was a historical consequence of the development of modern science and technology. The modernist historians viewed instead the reified status of technology and architecture as historical constants. Thus, technology suddenly became a mythic object as if a second nature, as did architecture as an artistic practice. Technology and aesthetics, thus mystified as universal categories, became two poles sustaining the narrative structure of modernist history. Given this, one can easily see that the synthesis of the two will be found in a convergence of technology and art, that is, an aestheticization of technology, an aesthetics of technological objects, guided by metaphysical principles outside their concrete dialectic, such as the spirit or a teleological movement of history. Thus, although the modernist historians took up the issue of modern technology, their histories were basically operating on the metaphysical principles of traditional history, even returning to the Hegelian philosophy of history that the traditional art historians of the Vienna school tried to overcome.

The methodological inconsistency of the modernist historiography bears difficulties which are not easily resolved in their histories. First of all, the synthesis of aesthetics and technology is clearly contradictory to the traditional formalist aesthetics upon which the modernist histories were implicitly based. As we have seen, after aesthetics was separated from science and technology, naive technology became its antithesis, and was considered to be ugly rather than beautiful. At best, it was considered to be "the sublime," which Kant identified as an experience of an object in nature, differentiating it from authentic aesthetic

[697] As Frampton observed, the mythological contradiction of Giedion's history is clearly shown in his inconsistent criteria for constituent facts, in which technology and formal principles are mixed. Ibid.

experience. The beautiful and the technological were irreconcilable within the traditional formal aesthetic system. No aesthetic criteria, whether aesthetic pleasure or the traditional formal criteria associated with beauty like harmony and proportion, was applicable to the technological object such as iron construction. It was basically for this reason that structural rationalism suffered from ambiguity, and that the efforts to develop aesthetic theories of iron construction based on such concepts as linearity and new spatial value up until the first decade of the twentieth century could not but fail at last.[698]

The Hegelian aesthetic concept that art is a material embodiment of the *Zeitgeist* of the machine age, which modernist historians relied on, clearly seems more applicable in this case. This is because in the Hegelian aesthetic of content, clearly more dialectical than Kantian formal aesthetics, the synthesis of technology and art might be claimed without explaining the essence of the aesthetic quality of the objects. However, the convergence of technology and aesthetics does not seem possible even in Hegelian aesthetics because the Hegelian aesthetics is originally based on the condition of non-alienated labor, a non-reified relation between subject and object, producers and products. Modern development of technology, however, brought about the fundamental alienation of the subject from its product, breaking the organic relation between the two. As Adorno put it, the domination of technology in the production of art and architecture tends to exclude any individualistic and humanistic meaning within the products.[699] More and more objectified, arts no longer embody any kind of spiritual content in the Hegelian sense. In fact, this was why Hegel talked about the end of art in modern technological society.

The re-integration of technology and art can be achieved through non-dialectical thinking sustained only by the metaphysical a priori. In reality, the separation between art and technology, thought and feeling, that the modernists conceived is not reconciled simply by the autonomous movement of history; nor is architecture a privileged means to achieve

698 For the summary of the formal aesthetic theories of iron construction, see Sokratis, "Introduction," in Building in France, Building in Iron, Building in Ferro-Concrete

699 Adorno, Aesthetic Theory (New York, 1984): p. 89

it. The technological and the aesthetic are, in fact, dialectic opposites of non identities.[700] Adorno pointed out the dilemma of the aesthetics of functionalism in Aesthetic Theory in this way:

> If one advocates the notion that real technological object are beautiful, . .then those objects are said to possess a quality which is by no means objective, matter of factness. . . . Those, on the other hand, who argue that a functional relation is necessarily beautiful to the extent that it adheres to its law of form are plainly apologetic because they pretend matter of factness is in possession of beauty where in fact it is not. . . . The autonomous work of art aims at attaining through its immanent teleology what was once called beauty. Non functional and functional technological art may converge in their sensitivity to matter of factness but a difference remains; the former retains the problematic ideal of beauty, whereas the latter can afford to abandon it.... If one follows the implications of matter-of-factness to their bitter end, one begins to notice something barbaric and pre-aesthetic in this approach. New Objectivity's finely tuned aversion to kitsch, to decorative and superfluous elements and to anything that smacks of luxury is barbaric in terms of Freud's theory of a destructive discontent with culture. The antinomies of matter of factness confirm the thesis about the dialectical nature of enlightenment in which progress and regress are intertwined. Literalness is barbaric. Completely objectified, art becomes a mere fact and ceases to be art. The crisis of functionalism opens up the possibility of a choice; either to give up art or to change its concept.[701]

At this point, Giedion's subjective interpretation of modern architecture could be seen as an attempt to avoid this dilemma of the aesthetics of functionalism by stressing a subjective rather than objective reconciliation. According to him, the reified status of technology from the subject is to be overcome at the level of the subjective psychic resolution rather than by the formal aestheticization of technology. As Michael Hays

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700 My understanding of the concept of non-identity is based on Susan Buck-Morss, The Origin of Negative Dialectics (New York: The Free Press, 1977) Chapter 3, "Dialectics Without Identity," pp. 43-62
701 Adorno, op.cit., p. 89-90

described, "as vision becomes an independent mode of reception, and as sight becomes a separate activity in its own right, they generate new objects of their own which . . . can, at the same time, be reconfigured and projected as possible solutions, on an aesthetic level, to that genuinely contradictory situation in the concrete world of everyday life from which they first emerged. The moment around which Giedion's interpretive system turns is a kind of visual wish-fulfillment."[702]

However, such a resolution by the centered subject of the bourgeois humanism is a myth. Since the centered subject of bourgeois humanism was already fragmented in modern technological society, Giedion's project was merely, as Micheal Hays suggested, "the protraction of the centered subject."[703] In fact, Giedion later recognized that technology is not a neutral fact upon which the subject can act freely, creating on it the image of the unified culture, but that there are inherently larger social implications and human relations invested in it, which he later found resulted in loss of humanity. Thus he gradually distanced himself from *Neue Sachlichkeit* and returned to the collective memory of architecture, searching for new monumentality.[704]

The mystification of technology by modernist histories had a very specific ideological function in the historical context of the late 1920s and 30s, a time when technology became more and more a means of domination rather than a means of emancipation.[705] Modern technology, developed as a result of reason's grip on nature, was originally conceived of as a liberating force for a progressive future and a means to achieve a new unified culture of modern society governed by reason and rationality. However, the critical rationality of the individual subject upon which the vision of the bourgeois society was based, was gradually replaced by instrumental reason or

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702 Michael K. Hays, Modernism and the Posthumanist Subject: The Architecture of Hannes Meyer and Ludwig Hilbelseimer (Ph.D. dissertation, MIT, 1990): pp. 46-47.
703 Ibid.
704 Frampton, op.cit.
705 Here I am using the concept of myth in Barthesian sense. See Roland Barthes, "Myth today" in Mythology (New York: Hill and Wang, 1969).

technological rationality working as an autonomous force.[706] The subject, alienated from technological process, now became an object of domination in spite of the original domination of subject over object. This process of reification of subject and object was the inherent antinomy of modern bourgeois society, and the dialectic of reason or enlightenment, analyzed by the Frankfurt School's critical theorists.[707] In fact, the failure of rationalism to create a new style relying on modern material and construction technology was, as discussed in previous chapters, a clear manifestation of the crisis of bourgeois culture based on the critical rationality of the individual subject.

The postwar European situation of the 1920s provided once again a unique space in which technology proliferated as a metaphor for social utopia. The technological process and rationalization were dominant principles of society and they were embraced by artists and architects with an almost blind faith in technology. However, the idea of a harmonious modern culture based on the technological utopia that the early modernists had, existed only temporarily, and was already becoming illusory in the historical context of the late 1920s and the early 30s.[708] With the failure of the attempts of historical avant-gardes to negate the bourgeois cultural system, the utopian implication of the technological metaphor of the 1920s disappeared and technology turned into mere technological rationality. In the condition of the increasing dominance of technology, the only way to escape bourgeois anguish, and thus legitimize bourgeois domination, was to mystify technology as something uncontrollable, as if a second nature; then, it would become possible to control technology or to reconcile it with the subject within the subjective consciousness under the illusory concept of bourgeois humanism. Beginning in the late 1920s, modernist artists

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706 See Marcuse, Ibid.

707 See Theodor W. Adorno and Max Horkheimer, Dialectic of Enlightenment (1944) (New York: Continuum, 1991)

708For a general introduction to the Weimar period and its collapse, see John Willett, Art and Politics, Weimar Period, New York: Pantheon, 1978. Also Manfredo Tafuri, "U.S.S.R..-Berlin, 1922: From Populism to "Constructivist International," in The Sphere and the Labyrinth (Cambridge, MIT Press, 1987) pp. 119-138 and architects mystified technology and fetishized technological objects in the name of *Neue Sachlichkeit*, separating them from the productive bases.[709]

In this historical context, the modernist historians taking up the issue of technology had a double task: the mystification of technology and subjectivization of architectural practice. The mystification of technology not only provided the image of a unified culture of the modern age, but also legitimized the subjectivization of architectural practice. Ironic as it may seem, taking up the issue of technology was a necessary step towards the subjectivization of architecture since, by doing so, technology became a legitimate part of architectural practice, but in a mystified form. The resolution of object and subject, and of technology and art claimed by the modernist historiography, was thus made possible at the level of consciousness. This was nothing but a compensatory act in the condition of the increasing domination of technology and the marginalization of the subject. The historical transformation of the architectural discipline from a technological innovation to a subjective aesthetic practice was a logical process in the domestication of technology. When Benjamin wrote the passage which I quoted at the beginning of this chapter in 1936, he was pointing out exactly what the problem of modernist histories was. While the cultural ideology of modernist historiography aestheticized and spiritualized technology, Fascism went further, to aestheticizing politics.

Recently, the mythical relationship between technology and modern architecture was rightly pointed out by many critics. Criticizing the modernist myth of the correspondence between technology and sign, the critics considered an architectural form a self-referential system, which they argued was the unique characteristic of artistic modernism.[710] Particularly under the strong influence of post-structuralist studies, recent revisionist critics tend to focus their analysis on subjective aspects of architectural forms; that is, the status of the

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709 On the technology cult of the 1920s, Andreas Huyssen made a brief comment in his introduction in The Technological Imagination: Theories and Fiction, (Madison, Winsconsin, 1980), p. 79-83. And Weissenhof Siedlung (1927) was a clear example of the aestheticized modern architecture.

710 For example, see Peter Eisenmann, "Post-Functionalism," in Oppositions vol. 6 (1975)

subject and the subjective conceptual categories inscribed in architectural projects. For them, architecture is seen above all as a subjective-cognitive practice, rather than a material process of building, without a clear distinction between artistic and architectural practice.

However, as I pointed out earlier, the subjectivization of architecture was exactly what modernist histories provided. Although the critics of modernist histories rightly severed from the technological reference of modern architecture, they tacitly accepted the aestheticization and subjectivization of architectural discipline. Thus, despite their claim to distance themselves from the humanist tradition of the modernist histories and their argument for the independence of form, they fundamentally inherited the terms that the modernist historians provided.

Although the objective technological change is undoubtedly dialectically related to that of the subjective condition, and architecture as a mediating practice between object and subject involves the subjective experience of the objective condition as well, the primacy of object over subject should be maintained. Theodor Adorno, one of the most dialectical theorists of modern culture, made this point clearly when explaining the development of modern art in the dialectic of subject and object.[711] This dialectic is even more pertinent to architecture, since its object is bound up in technical and material conditions to a greater degree than in any of the arts.

The issue of material and technological innovations, therefore, is the most important factor, or the "first instance" to be considered in the discussion of modern architecture. The modernist historians' concern with the relationship between modern technology and architecture is still valid. What should be criticized instead is the mystified concept of modern technology and its non-dialectical relation to architecture. Therefore, the task is not to drop modernist histories as a myth and to return to the formalist or subjective study of architecture, but to confront the issue of technology. Not that technology can create a new

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711 See Theodor Adorno, "Subject and Object," The Essential Frankfurt School Reader, ed. Andrew Arato, (New York: Continuum, 1987) 500- 503

architectural form or style, but that technology is intrinsically related to architecture in the production process as a material condition.

The concept of technology and its relation to architecture should be understood in a different way from what the modernist historians asked us to believe. Instead of inquiring into the subject's attitude towards the technological condition, whether one accepts it as aesthetic or not, like modernists, one should ask questions of technology in the architectural mode of production. In this regard, Benjamin raised a very crucial question in "The Author as Producer," published in 1934, around the time modernist histories took shape:

> Instead of asking, "What is the attitude of a work to the relations of production of its time? Does it accept them, is it reactionary - or does it aim at overthrowing them, is it revolutionary - instead of this question, . . . I should like to propose another. Rather than ask, "what is the attitude of a work to the relation of production of its time' I should like to ask, "What is its *position* in them." This question directly concerns the function the work has within the literary relations of production of its time. It is concerned, in other words, directly with the literary *technique* of works.[712]

The question touches the very concept of architecture and architectural practice in a quite different way from those of modernist historians. In this essay, Benjamin introduces a concept of technique in literature as a new device for surpassing the unfruitful antithesis of form and content, and of political tendency and artistic quality in modern art. The concept of technique in literature provides a measure for the progressiveness of the work in terms of both artistic quality and contemporary productive conditions. At issue here, of course, is not the representation of machine aesthetics in the work of art, but how to use the techniques critically by reorganizing them. Likewise, it could be argued that the antithesis of technology and art, of engineering and architecture that the modernist historians tried to

712 Walter Benjamin, "The Author as Producer," in Reflections (New York: Schocken, 1969) p.222.

resolve, can be surpassed by the Benjaminian concept of techniques. The issue of the artistic form of technological objects with which the modernist historians were obsessed is a totally irrelevant question here because, as Tafuri put it, "engineering represents the positive legacy of the impracticable utopian ideas that had threatened the sphere of language."[713] What is crucial is the correct use of technology in the process of architectural production, which inevitably includes socio-economic and political processes.

In fact, some architectural practices within the modern movements took a different position in the contemporary architectural relations of production from that of the modernist architects and historians. They did not take technology as a separate fact, an object of representation, but fully understood the social implications involved in technological processes. Crucial for them was to use technology critically in the process of production, directly intervening into the relations of production, and reorganizing them in such a way that technology could serve better for its purposes. For them, the issue of endowing technology with a form of harmonious modern culture at the level of image was only secondary. In fact, after Art Nouveau, various modern movements focused on this aspect of modern technology and industrialization, rather than on the creation of a new form. Despite many differences between them, I believe that architects and theorists such as Muthesius and Loos engaged themselves in this issue of production without obsession about the creation of a new style. Within the modernist avant gardes of the early 1920s, artistic practices such as productivism and constructivism experimented this way. As has been noted by Tafuri, Martin Wagner's social housing projects in Berlin during the 1920s could be taken as an example of the Benjaminian architectural practice.[714]

However, it is also true that the issue of form and language in architecture would not be automatically solved, no matter how rationalized and industrialized architectural

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713 Manfredo Tafuri, "Soziapolitik and the City in Weimar Germany," in The Sphere and the Labyrinth. Quoted from Ludovica Scarpa, "Rationalization and its Form" in Rassegna, 63 (1982), the first page of English translation.

714 See Ludovica Scarpa, "Rationalization and its Form," in Rassegna, 5 (1981).

production becomes. Thus the tension between technology and form remains unresolved. As already discussed, in the lack of authentic representation in the modern age, any attempt to give a totalizing image is a suspicious act. Adorno had suggested that in order to resist any attempt for an easy communication, modern art should return to its own artistic materials. In this respect, the act of negation in the sphere of language, which is practiced by the so-called posthumanist architects, might be justified. But the subject matters that they are scandalizing are the subjective conceptual categories that are themselves a legacy of the modernist utopia, a desire to communicate or to control. They thus maintain the nostalgia for architecture's cultural role, while missing many other technological issues in architecture that should be addressed-- such as environmental issues and technological innovations and so on. It should be remembered that the lesson from the failed rationalism was that the ambition of architecture to play a cultural role was overstated. The subject matter for the critique of representation should be material and technology in architectural construction, not abstract, subjective categories of architecture, which are already ideological. Yet without the rationalist belief in the correspondence between technology and sign, architectural form is a result of a pure aesthetic game. Such a gap between technology and form is a fundamental dilemma of modern architecture that we have to live with. In this respect, the history of architectural modernity should also be re-examined. My dissertation takes only the first step in rethinking modern architecture in this sense.

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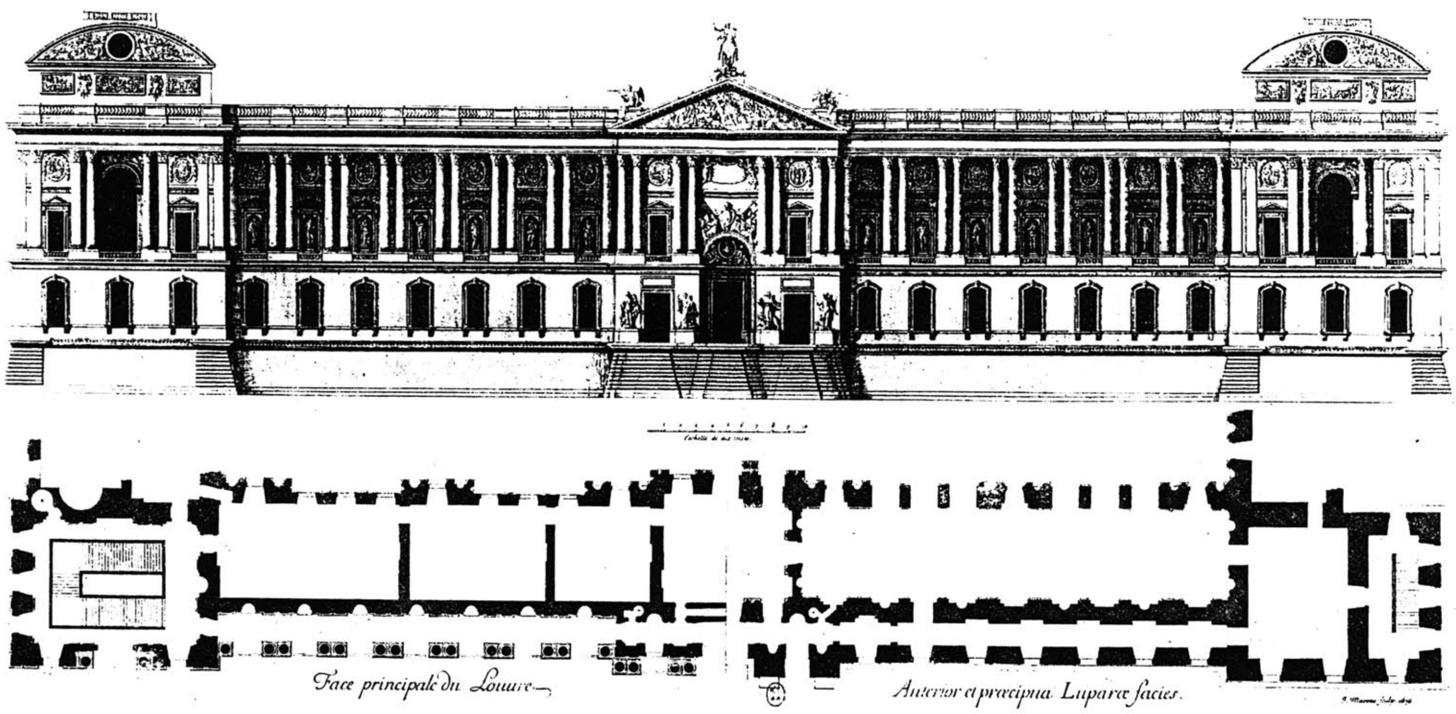
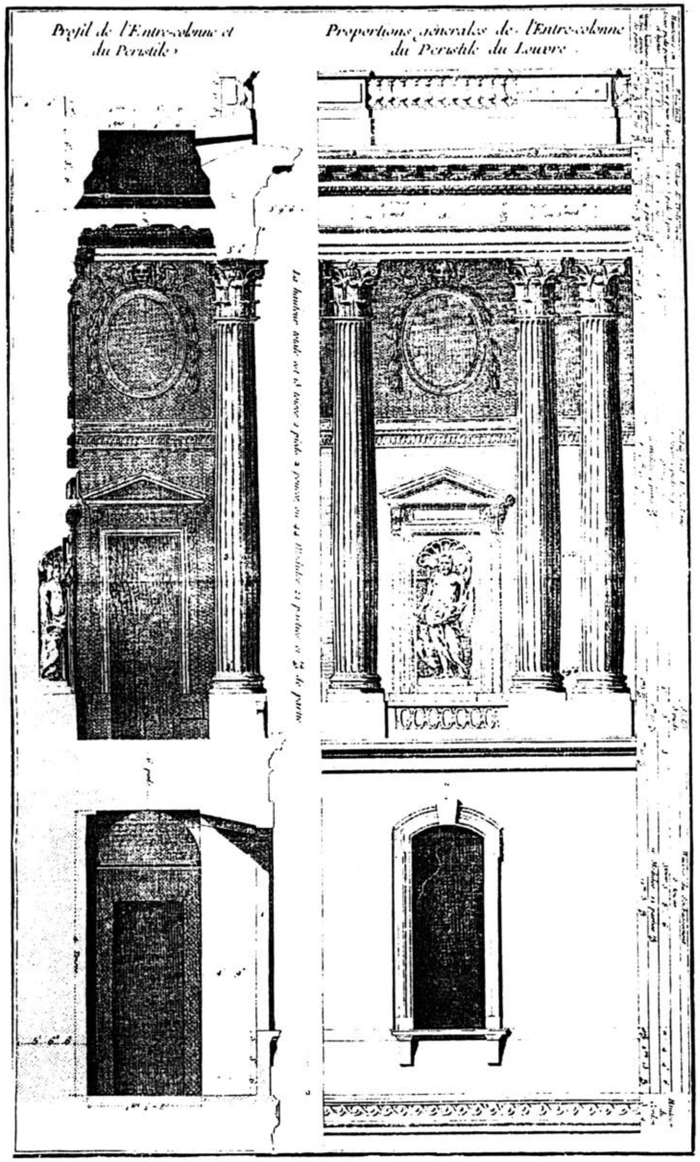
Illustrations

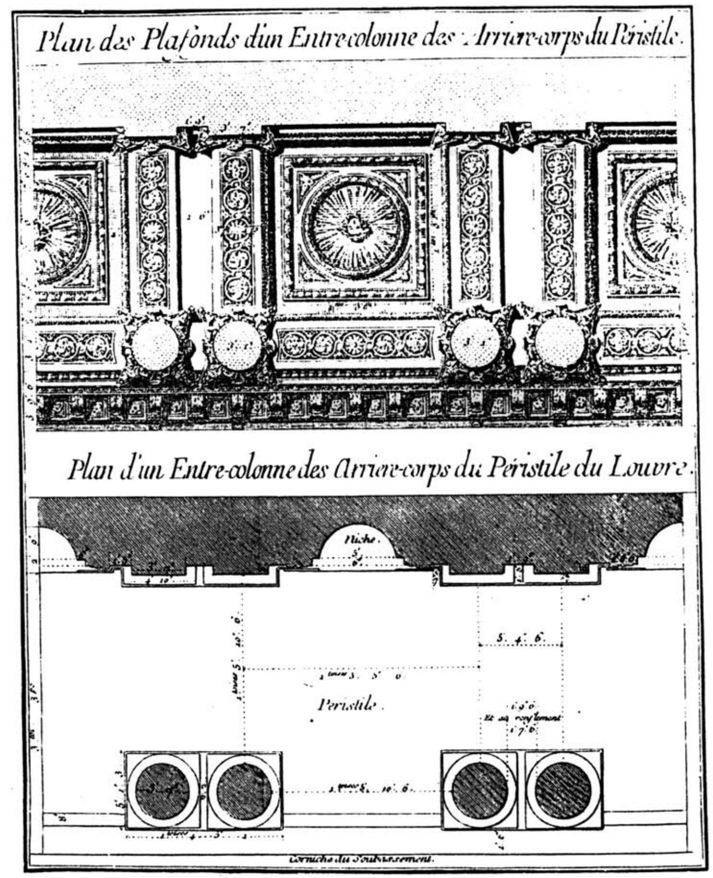
(fig. 1) Claude Perrault, final design for the east facade of the Louvre



128. « Face principale du Louvre », gravé par J. Marot (1676). Les attiques de Perrault figurent sur cette version de la colonnade qui montre également le soubassement qu'on avait pourtant renoncé à laisser à découvert à cette date.

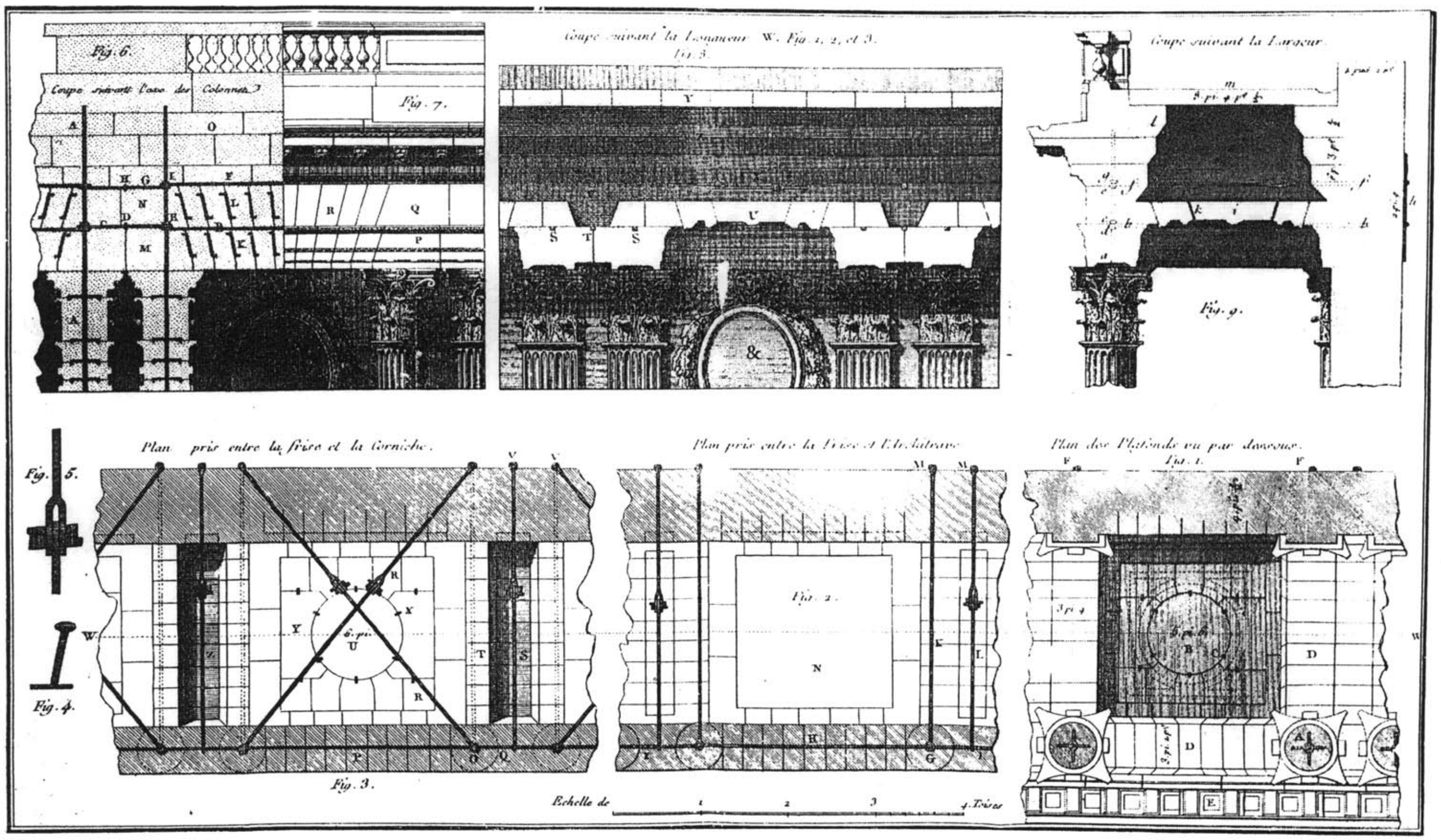
(fig. 2) Detail of the peristyle with coupled columns



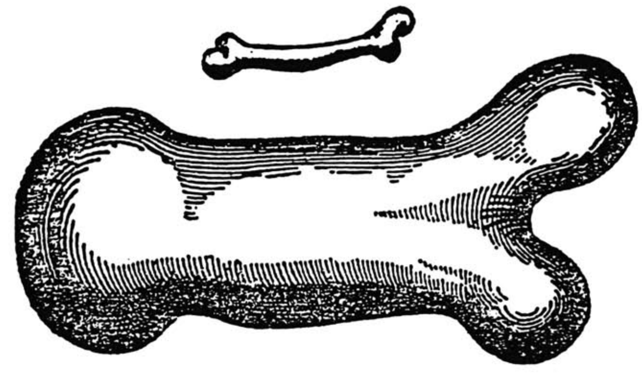


136, 137. P. Patte, Mémoires sur les objets les plus importants de l'architecture *(1769), relevés du péristyle du Louvre.*

(fig. 3) Iron reinforcement of the east facade of the Louvre

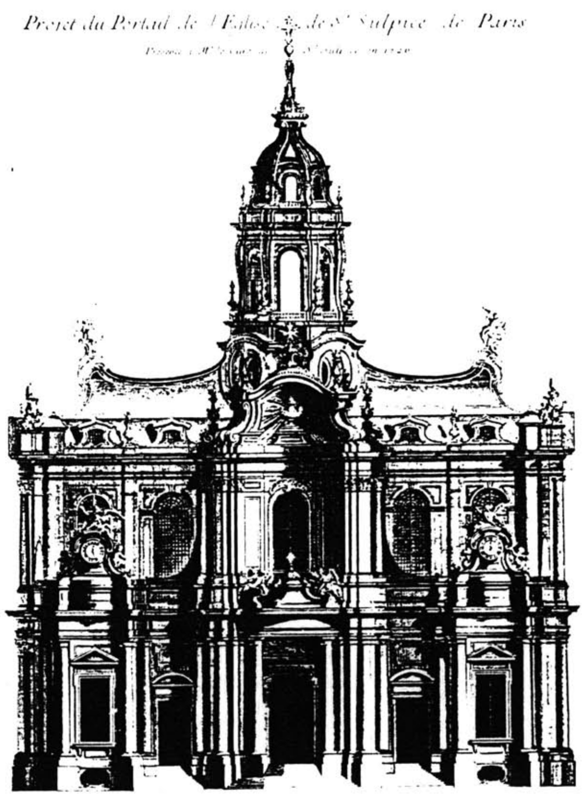


144. P. Patte, Mémoires, *construction des plates-bandes et des plafonds du péristyle du Louvre. Toutes les armatures en fer de la colonnade sont détaillées sur cette planche.*



21. Illustration from Galileo's Due nuove scienze *demonstrating the doctrine of the invariance of proportions to be false, as invalid in the natural world as in the world of design. This is one of the first examples of the mechanization of the conception of natural objects and is also an early instance of biometry.*

(fig. 4) Illustration from Galileo's Due nouve scienze



(fig. 5) Meissonier's project for the Church of St.-Sulpice, 1726

FIG. 103 M.-A. Laugier, *Essai sur l'architecture* (1753), frontispiece.

(fig. 6) M.-A. Laugier, model of the primitive hut, 1753

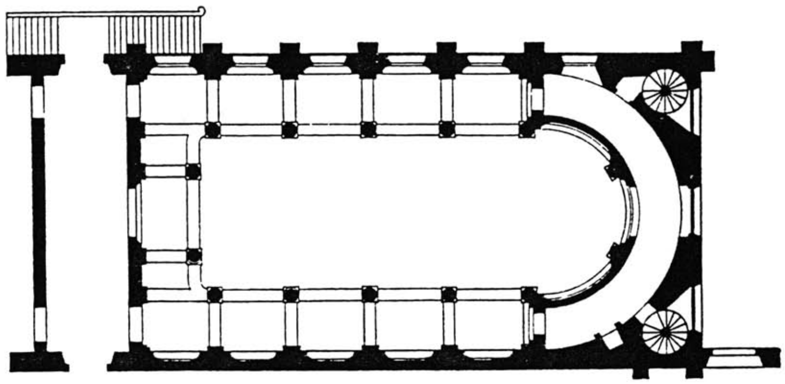
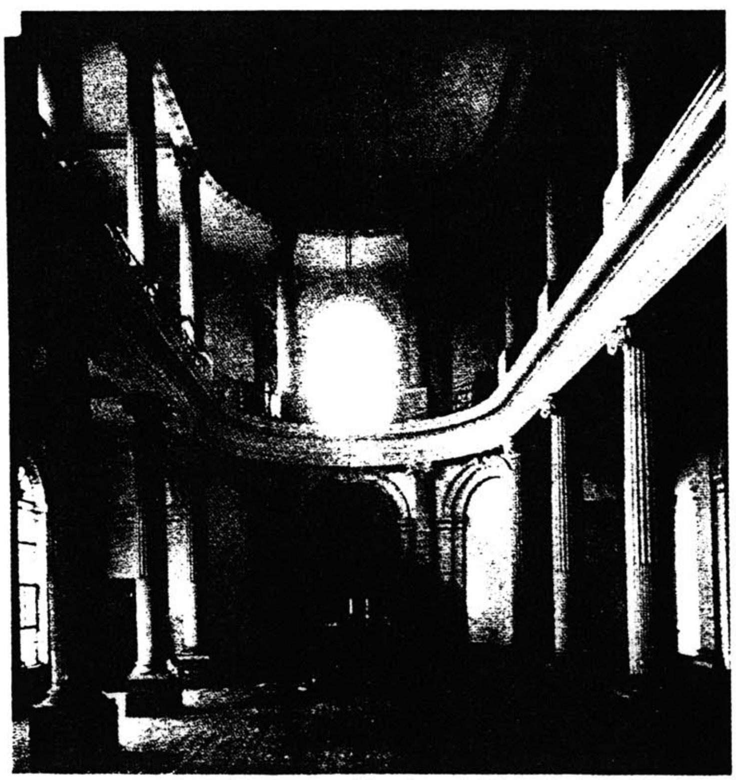


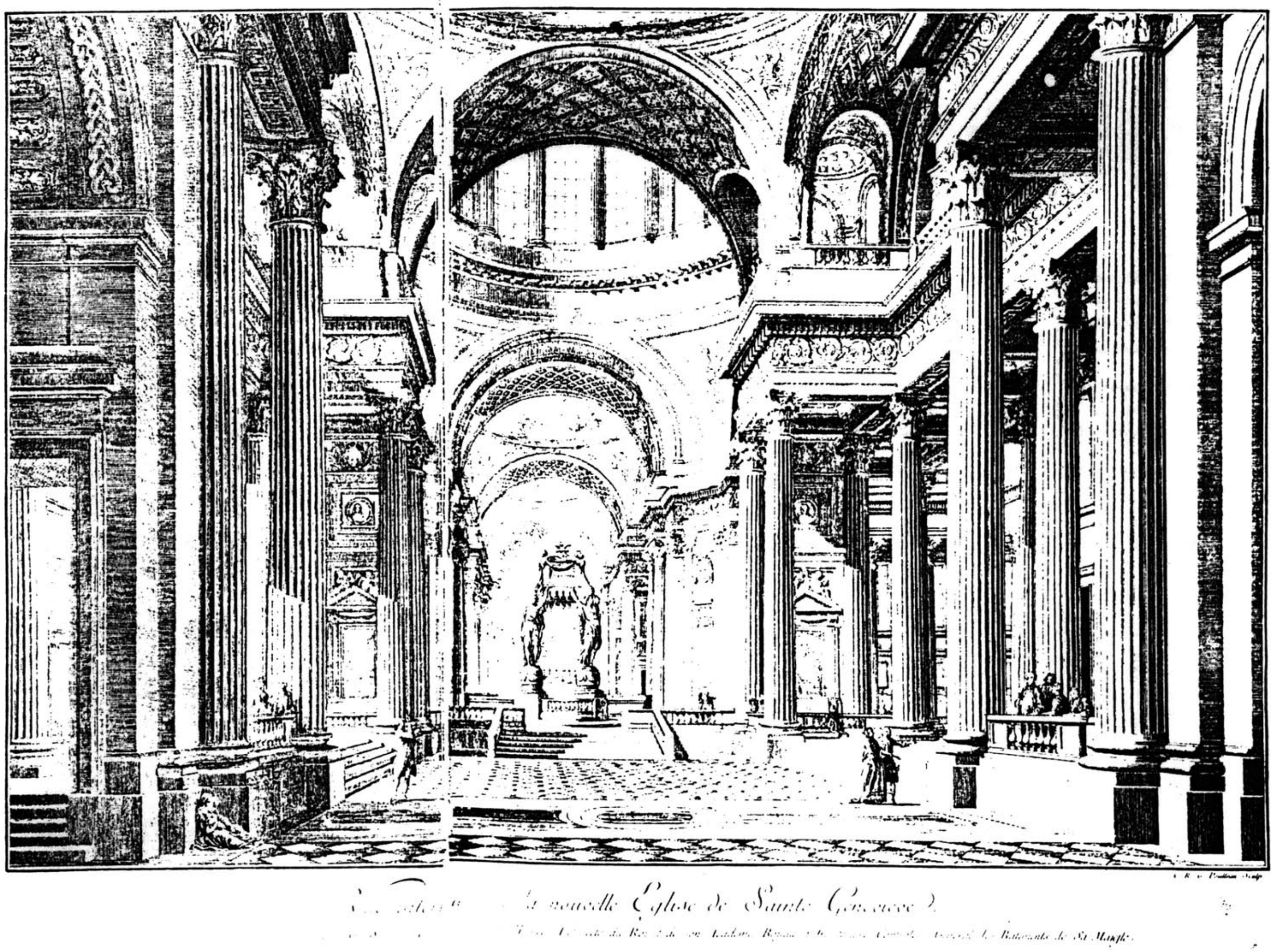
Fig. 3—Plan of Lunéville chapel.



d—Interior of Lunéville chapel. (*p.* 307)

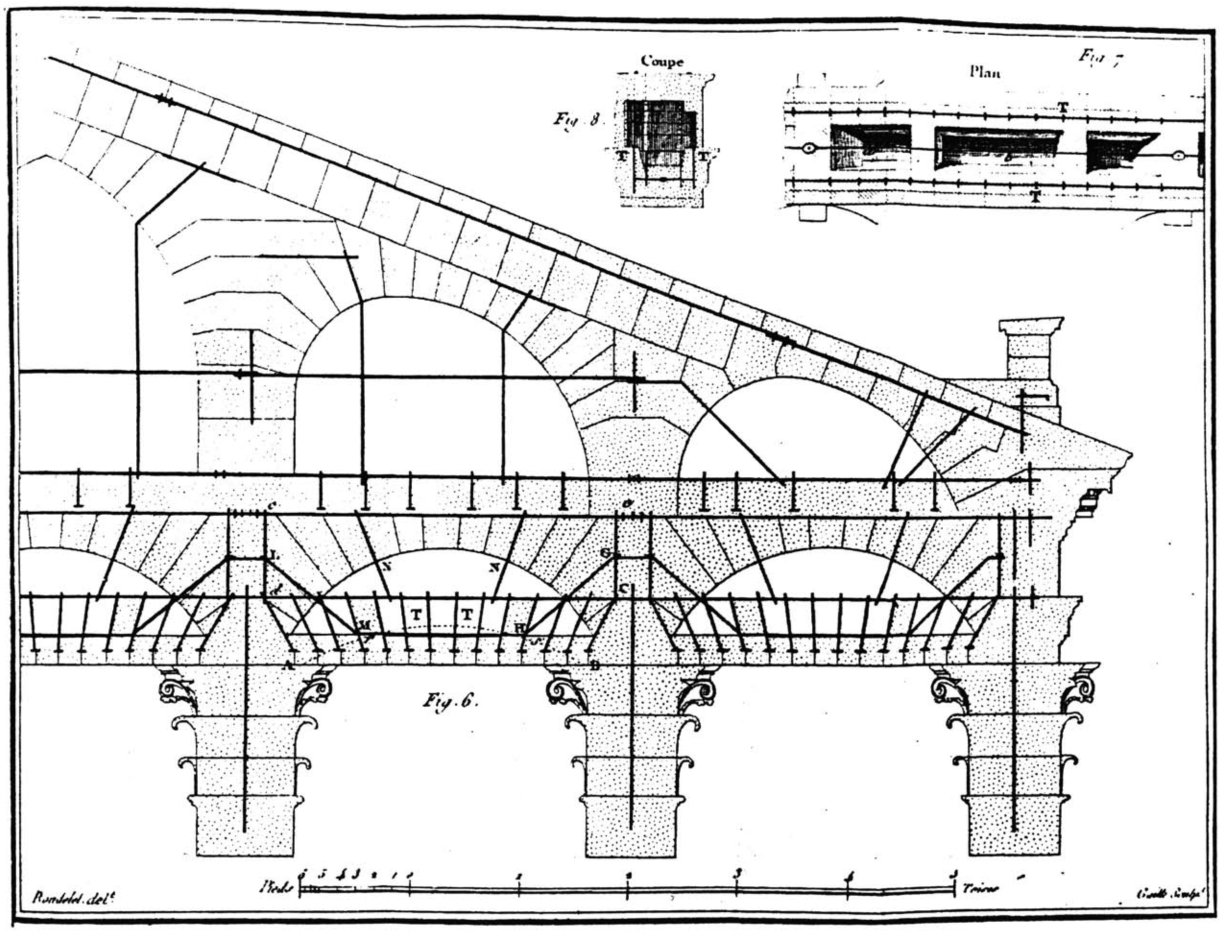
(fig. 7) Boffrand, plan and interior of Lunéville chapel, 1719

(fig. 8) J.-G. Soufflot, church of Ste.-Geneviève, 1757 (fig. 9) J.-G. Soufflot, church of Ste.-Geneviève, interior view

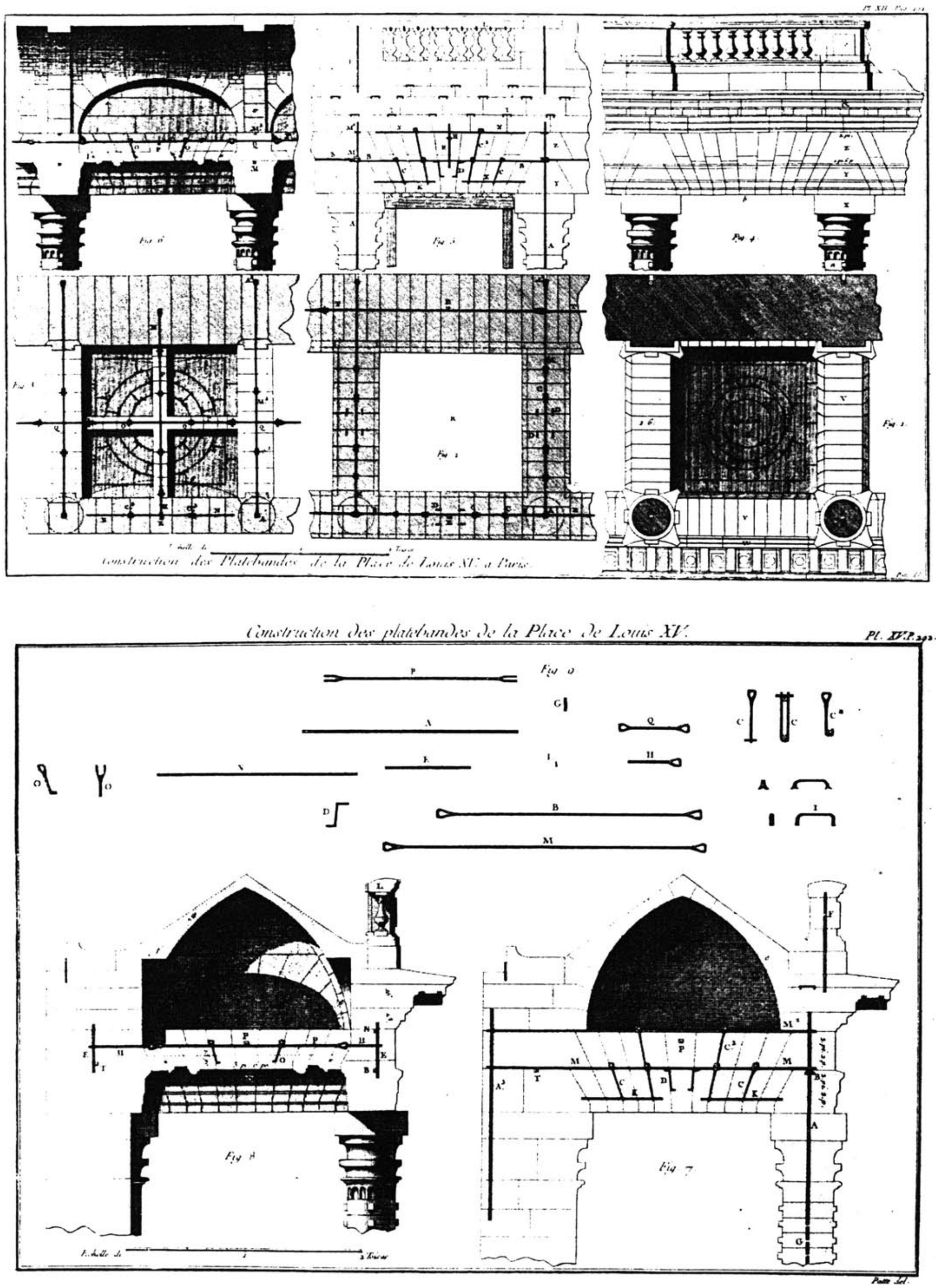


7

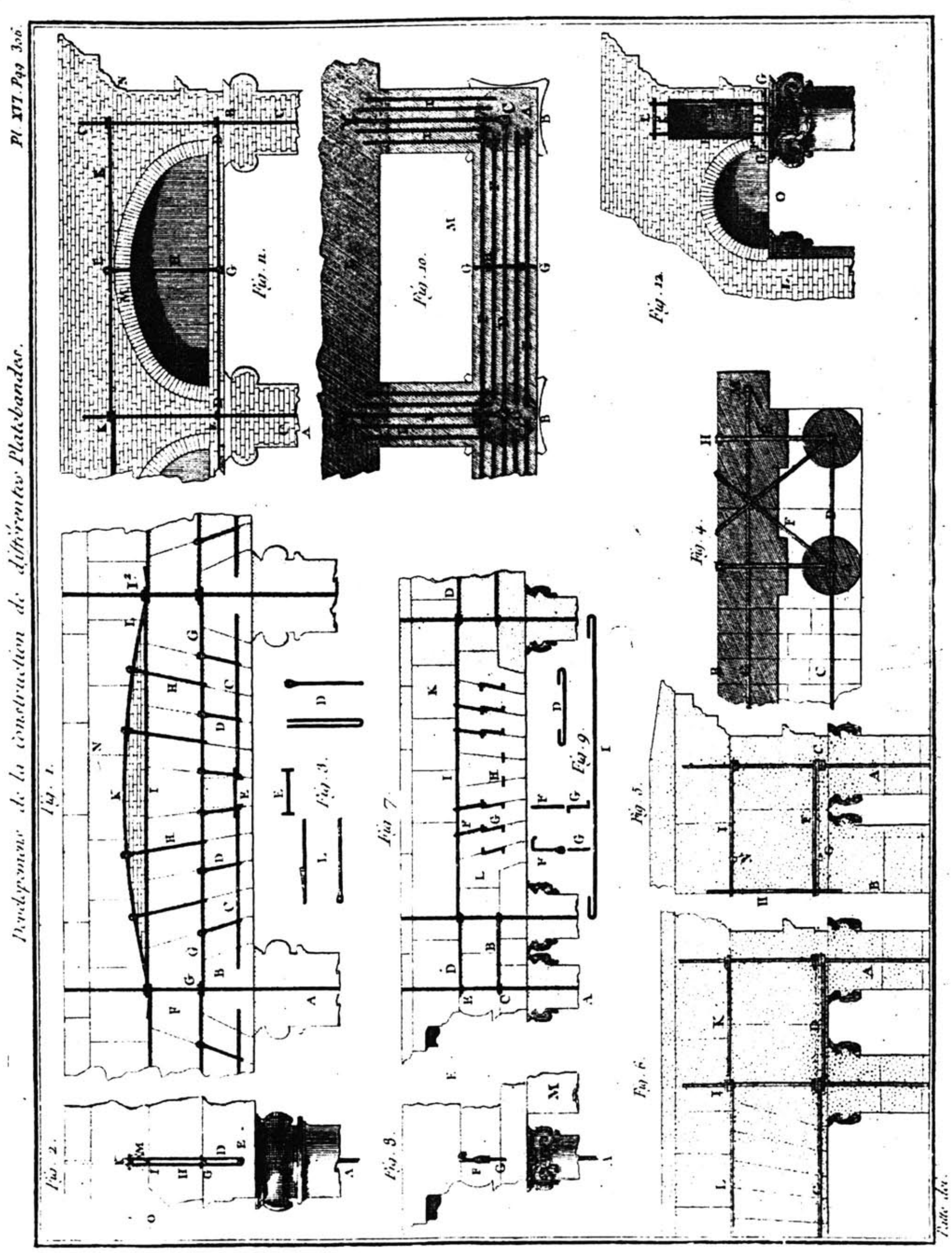
7 « Vue intérieure de la nouvelle Eglise de Sainte-Geneviève », gravure de Poulleau.



(fig. 10) A.-J.-B. Rondelet, iron reinforcement of the church of Ste.-Geneviève



(fig. 11) Iron reinforcement of the Palace de Louis XV, from Patte, Mémoires sur les objects les plus importants de l'architecture (1769)



(fig. 12) Example of iron reinforced lintels, from Patte's Mémoires sur les objects les plus importants de l'architecture (1769)

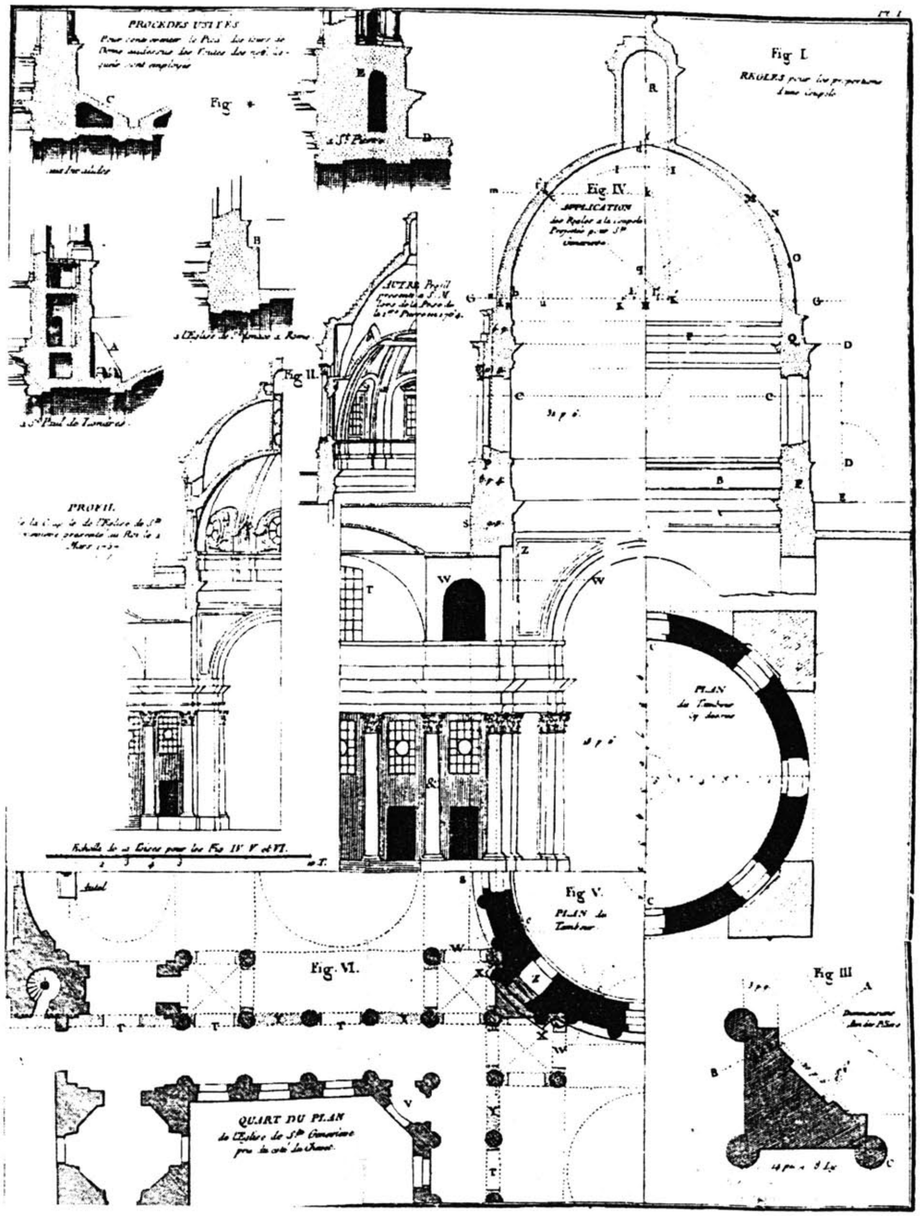


FIG.61 P. Patte, *Mémoire sur la construction de la coupole projetée pour couronner la nouvelle église de Sainte-Geneviève à Paris* (1770), plans and sections of the dome of Sainte-Geneviève.

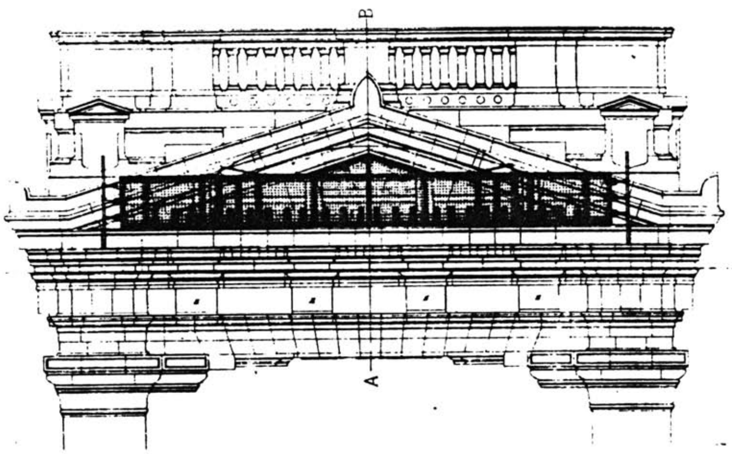
(fig. 13) P. Patte, plans and sections of the dome of Sainte-Geneviève, <u>Mémoire sur la construction de la couple projetée pour couronner la nouvelle église de Sainte-Geneviève `a Paris</u> (1770)

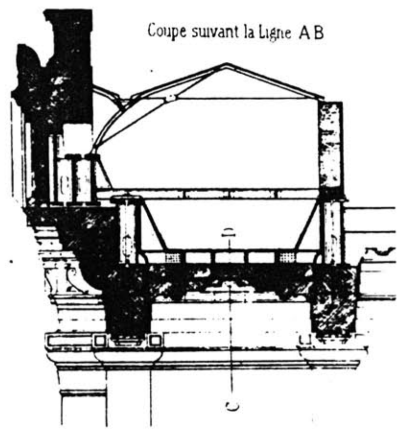
Modell des Justizpalastes in Brüssel
(Architekt: Joseph Poelaert)
mit einer Variante der oberen Bekrönung, 1875.
Sammlung Storrer

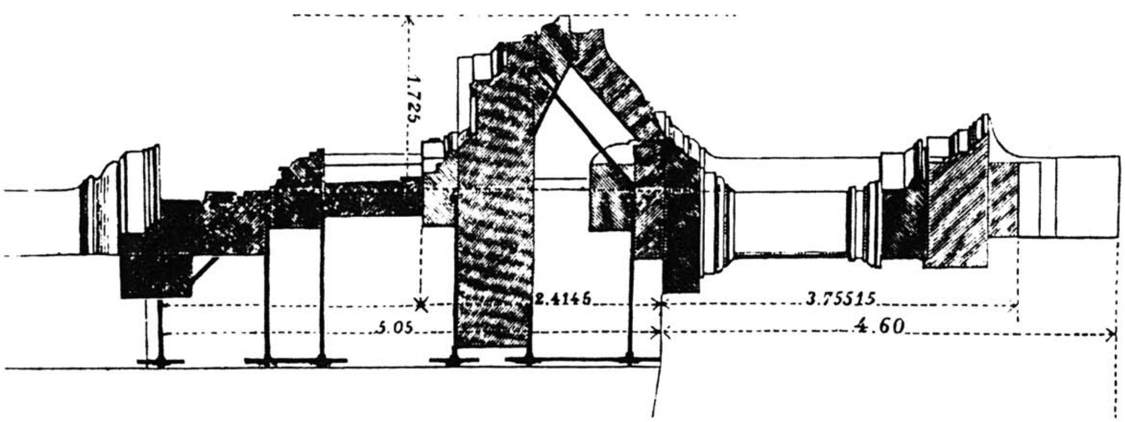
Model of the Palace of Justice in Brussels
(Architect: Joseph Poelaert) with a variation
of the upper crowning, 1875.
Storrer Collection

Ansicht und Schnitt des Sturzes
über dem großen Portal

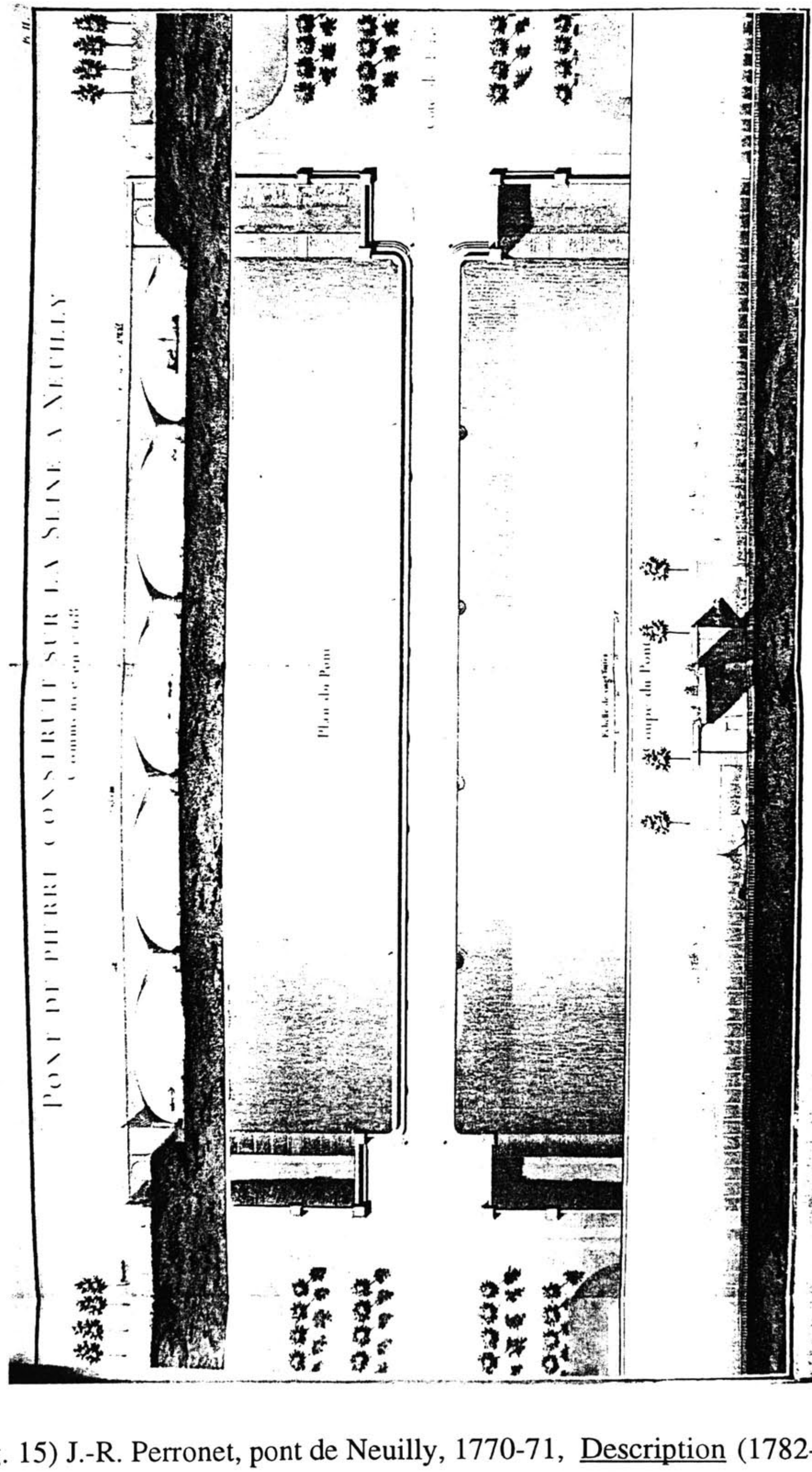
View and section of the lintel
above the great portal



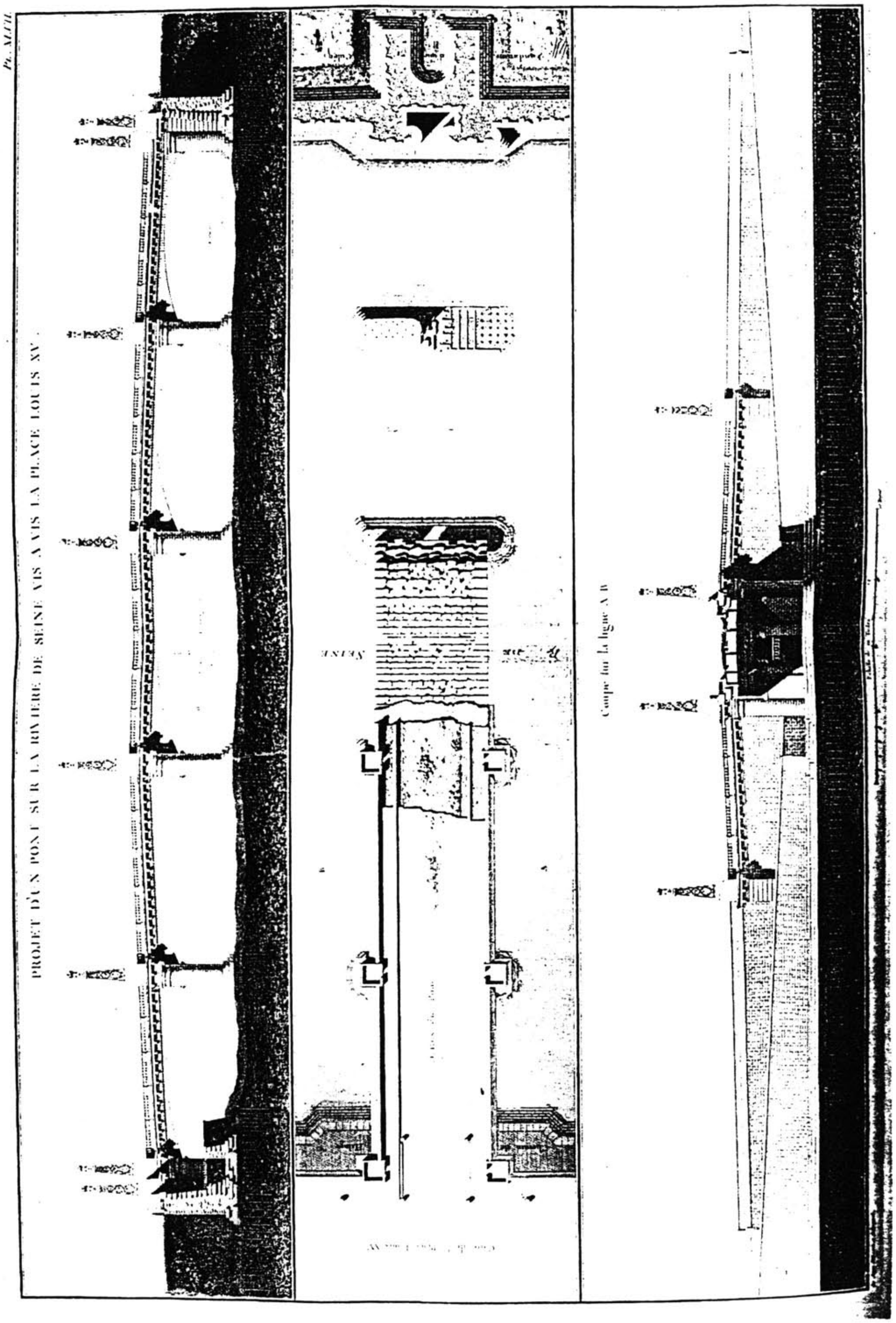




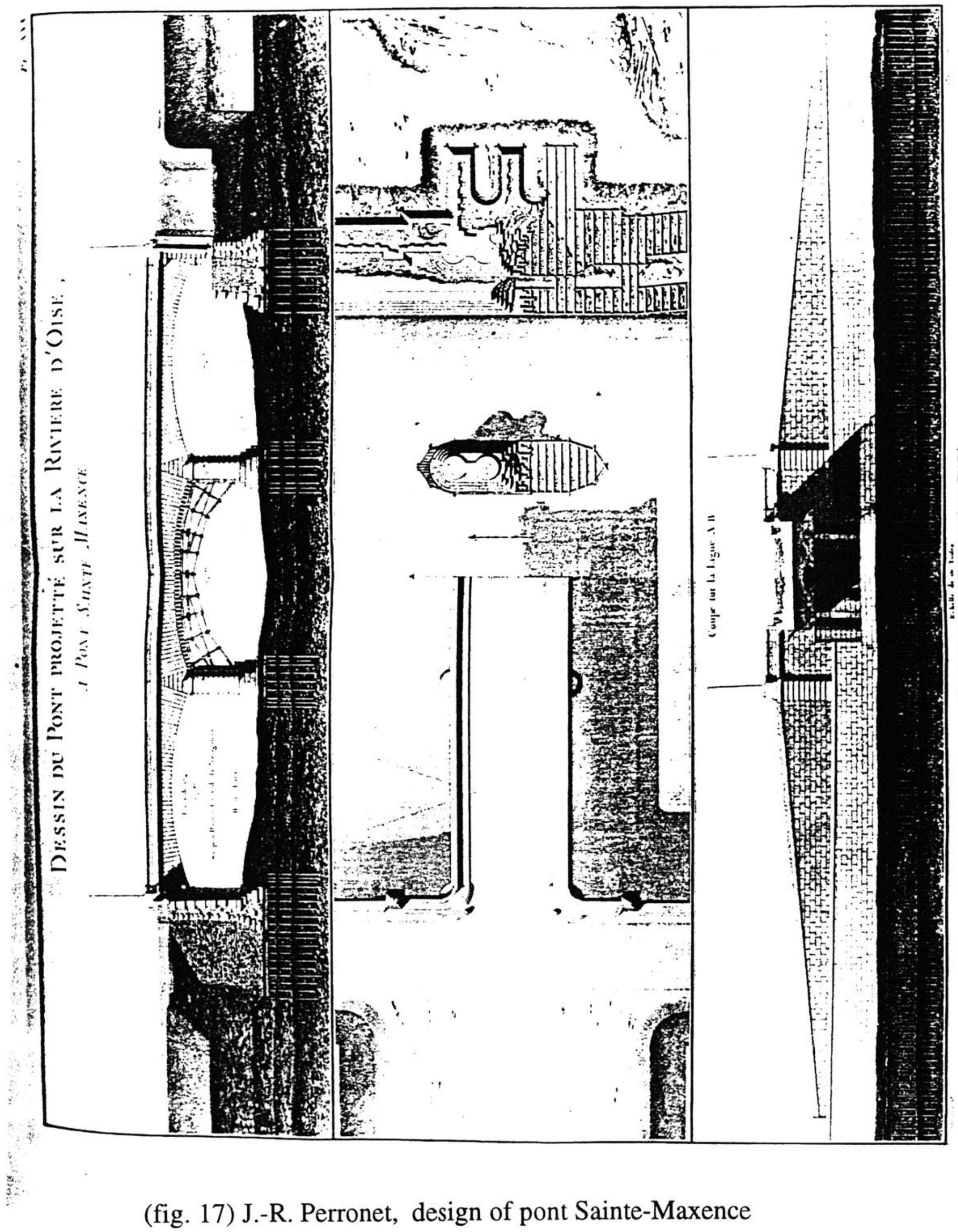
(fig. 14) Example of simple stone screen with iron structure. François Wellness, Palace of Justice in Brussels, 1881.



(fig. 15) J.-R. Perronet, pont de Neuilly, 1770-71, Description (1782-3)



(fig. 16) J.-R. Perronet, pont Louis XVI, <u>Description</u> (1782-3)



(fig. 17) J.-R. Perronet, design of pont Sainte-Maxence

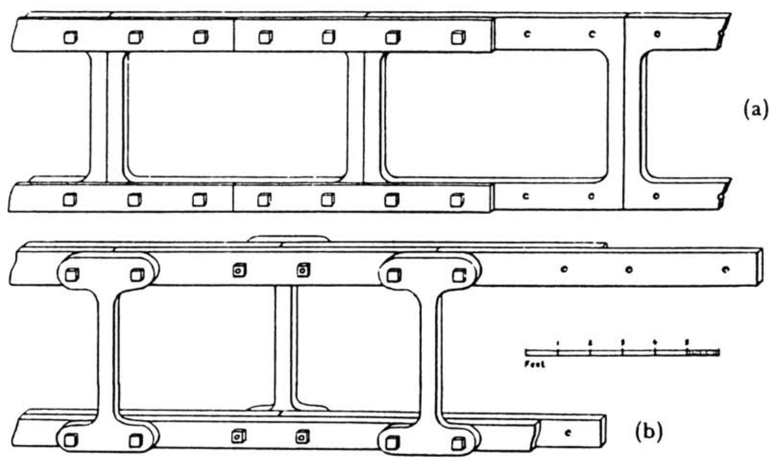


Figure 3. Reconstruction of Montpetit's rib-systems: (a) 1778 design, with cast-iron voussoirs and wrought-iron straps (from Perronet's description), (b) 1779 design, with wrought-iron laminated ribs (from Montpetit's drawing).

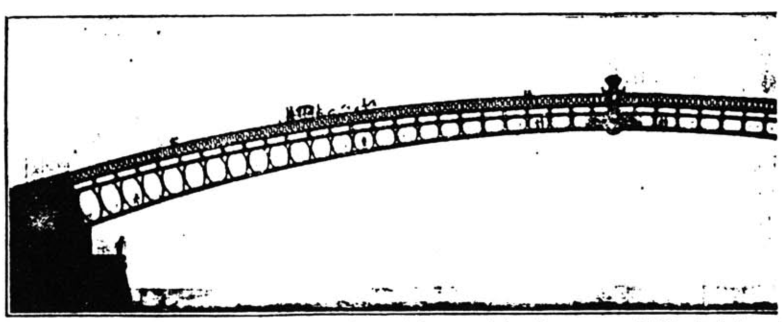


Figure 4. 400-foot bridge drawing from Montpetit's *Prospectus*, 1783: left-hand half of the view in elevation.

(fig. 18) Reconstruction of Montpetit's rib-system, from J.-G. James, Iron Arched Bridge Designs in Pre-Revolutionary France," History of Technology, (1979)
(fig. 19) Montpetit's proposal for iron bridge, 1779, from Montpetit's Prospectus (1783)

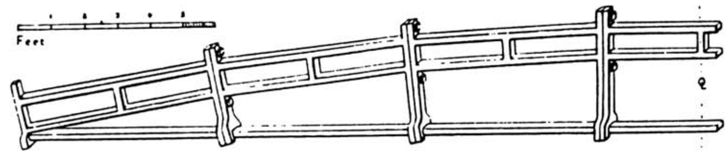


Figure 5. Racle's first system, 1783: early design for a 40-foot span (based on Racle's description).

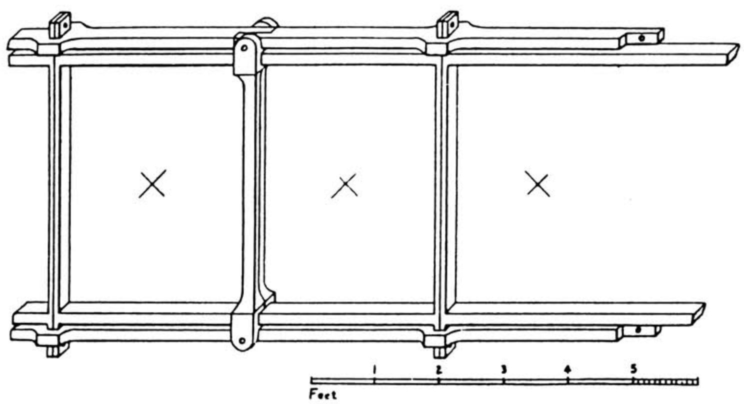
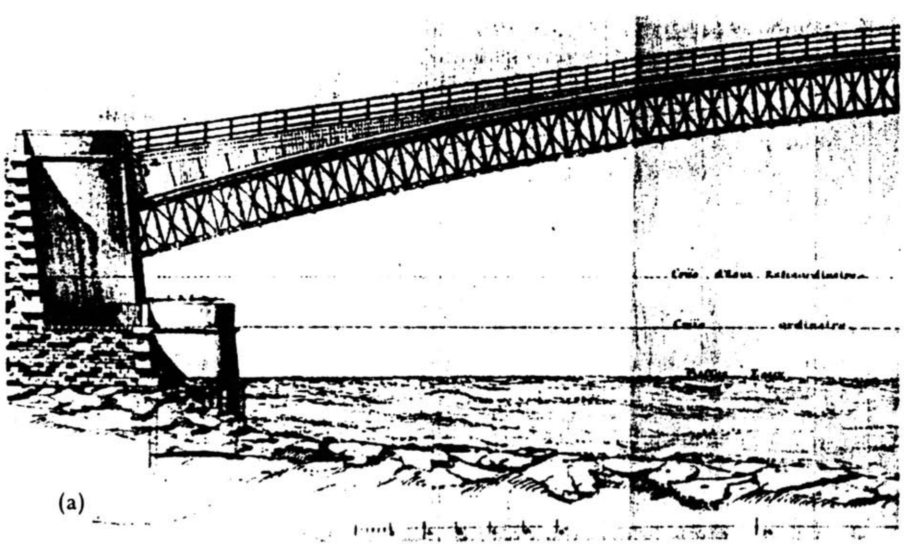
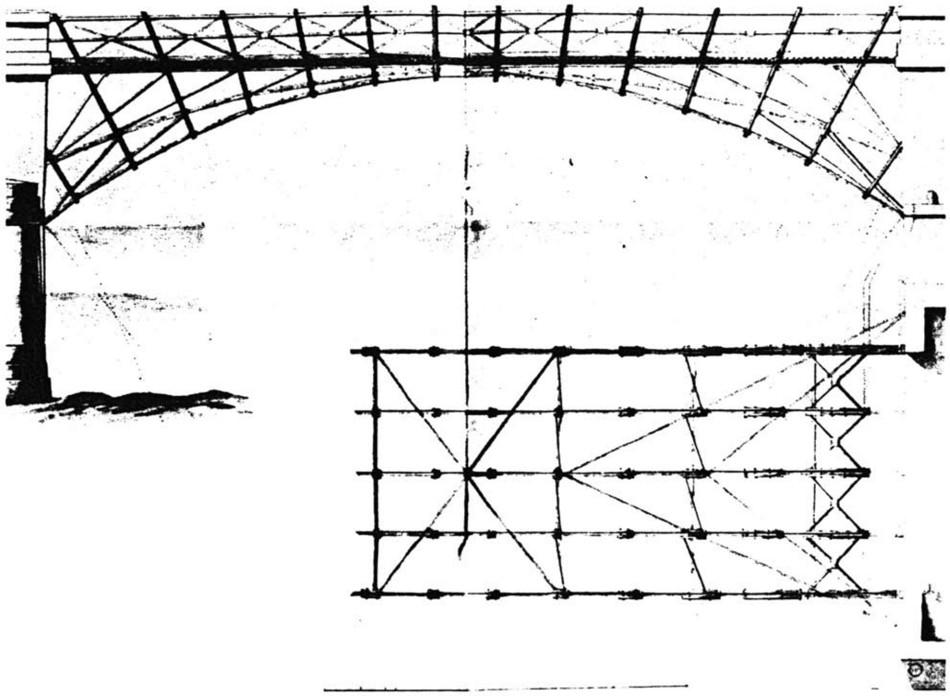
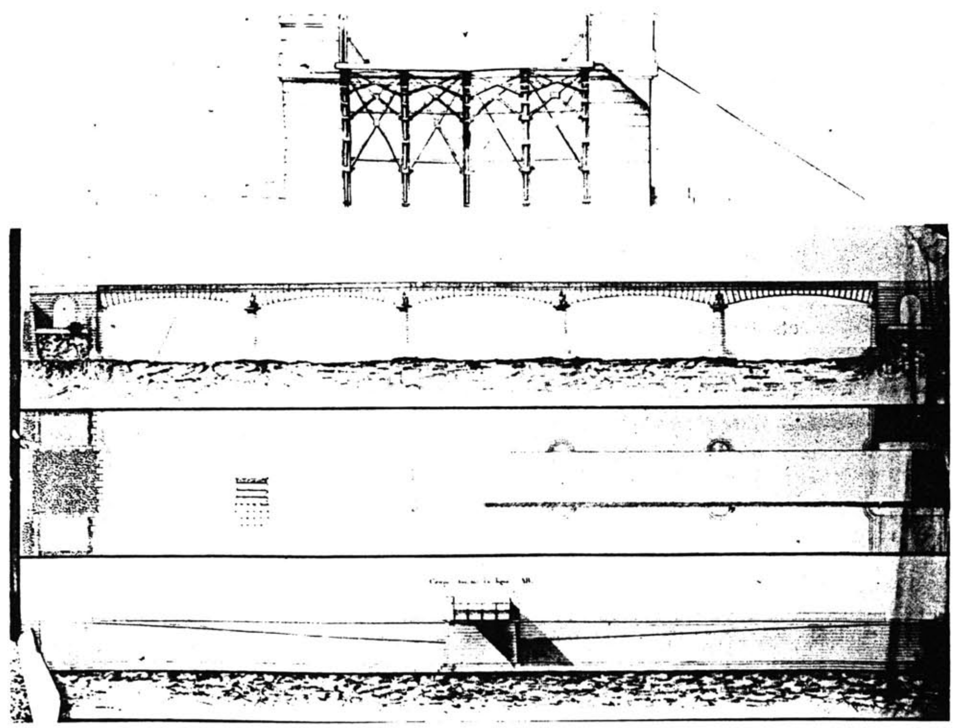


Figure 6. Racle's second system, 1783: detail of 126-foot span design (based on Racle's description and drawings). The crosses indicate the diagonal bracing sketched by Racle, details of which were inadequately worked out in his original drawing.



(fig. 20) Racles' proposal for iron bridge, 1783





(fig. 21) De Rosnay's patent for a system of cast iron bridge, 1786
(fig. 22) Project for an iron bridge, École Polytechnique, 1790

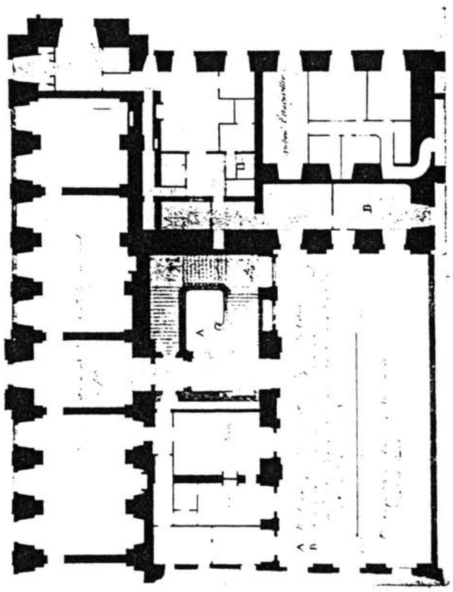


Fig. 6. Design for Soufflot's staircase, ground floor (Archives Nationales, O^1 1670, 228).

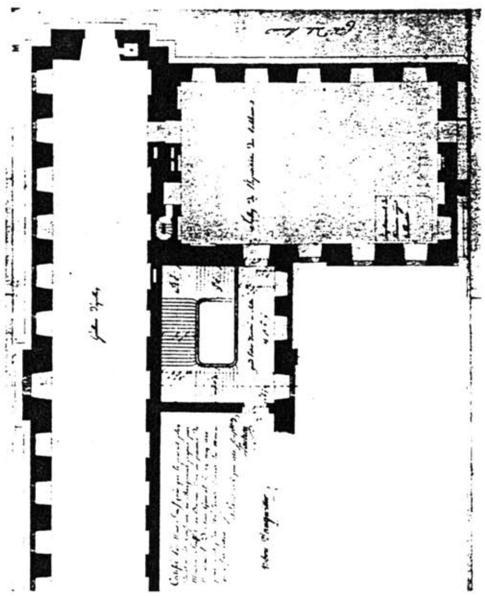
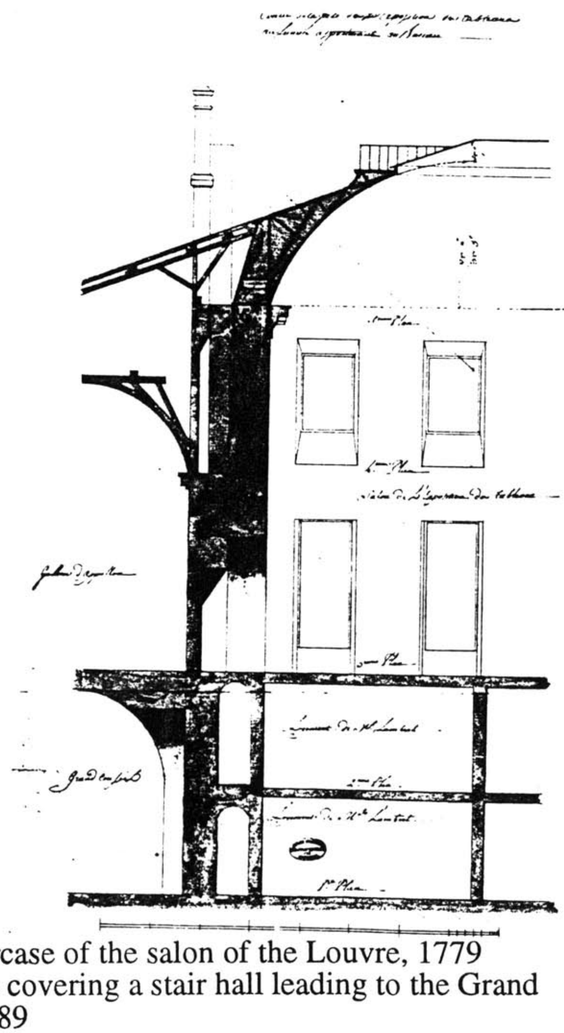
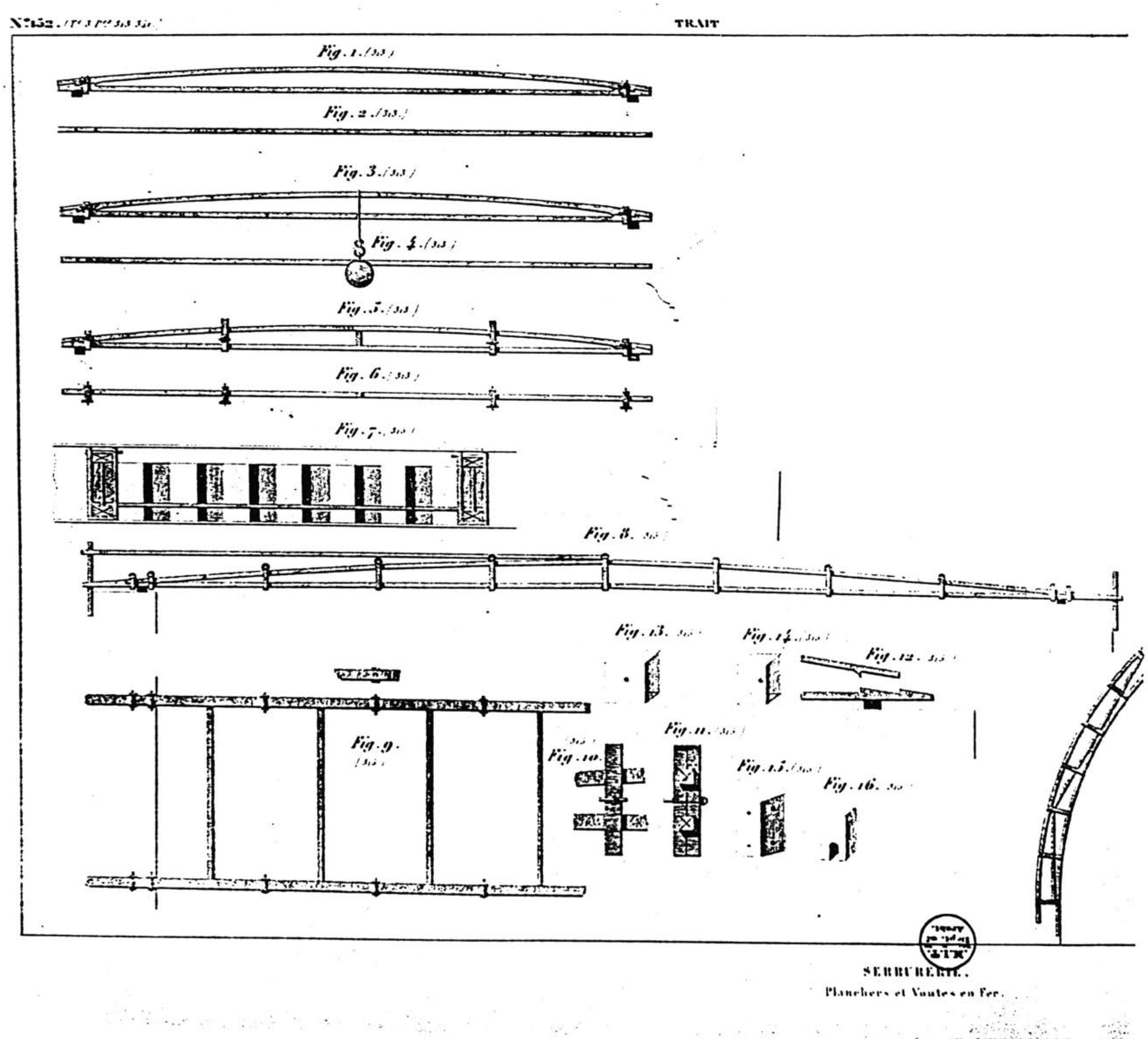


Fig. 7. Design for Soufflot's staircase, first floor (Archives Nationales, O^1 1670, 228).

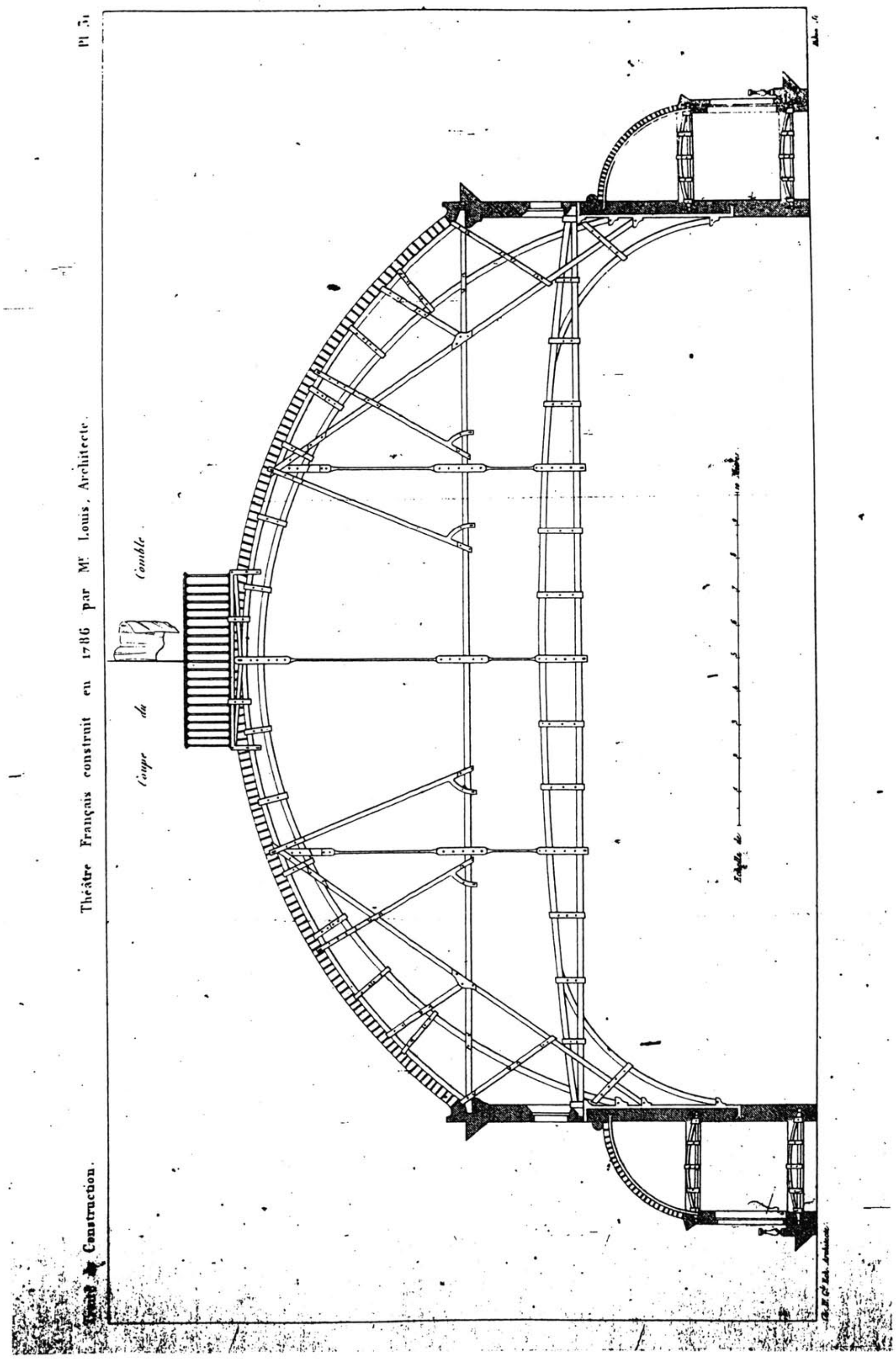
Fig. 16. Etching by Gabriel de Saint-Aubin, *View of the Salon of the Louvre in the Year 1753* (Bibliothèque Nationale).



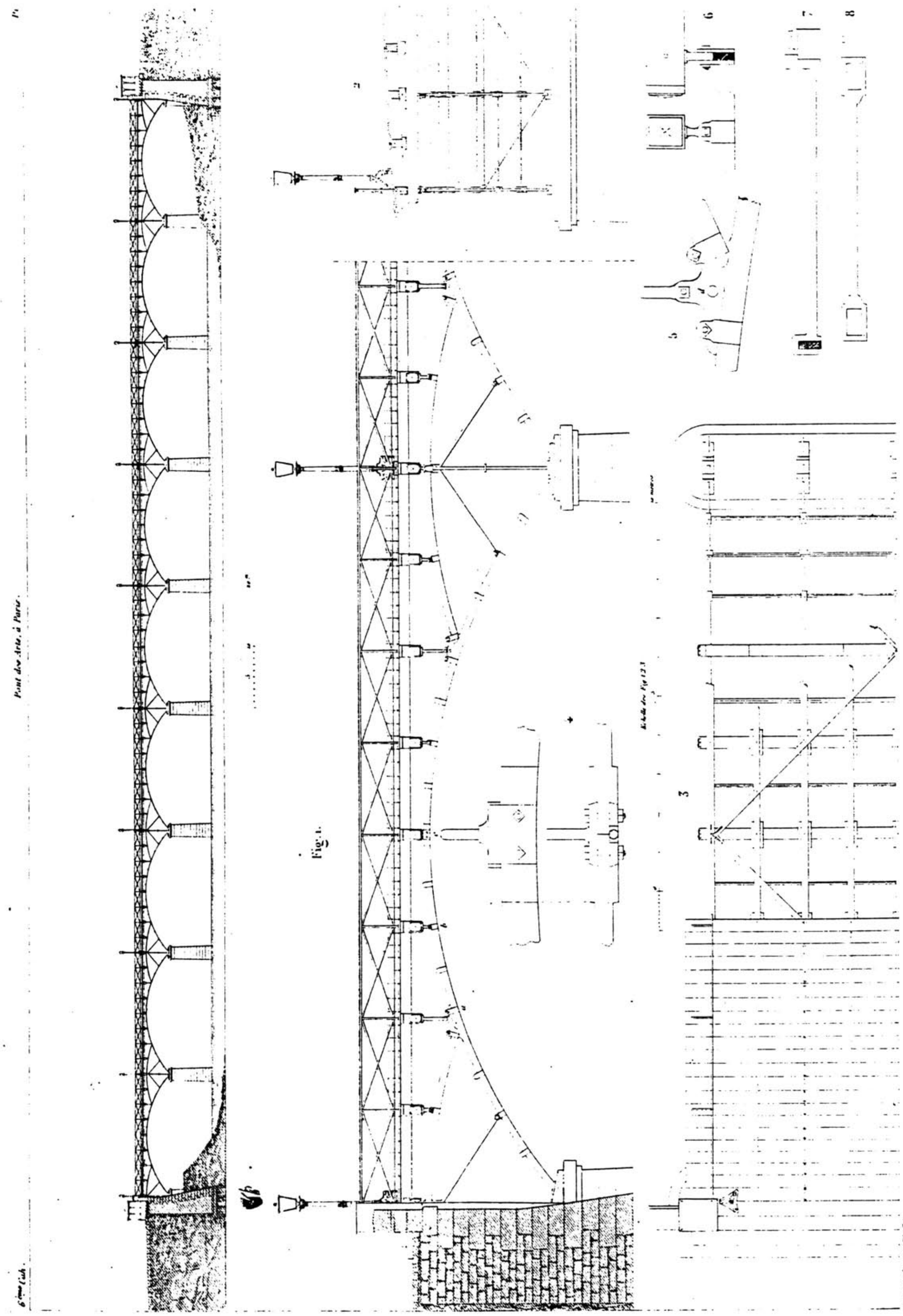
(fig. 23) J.-G. Soufflot, iron staircase of the salon of the Louvre, 1779
(fig. 24) Renard, iron roof frame covering a stair hall leading to the Grand Salon and the Grand Gallery, 1789



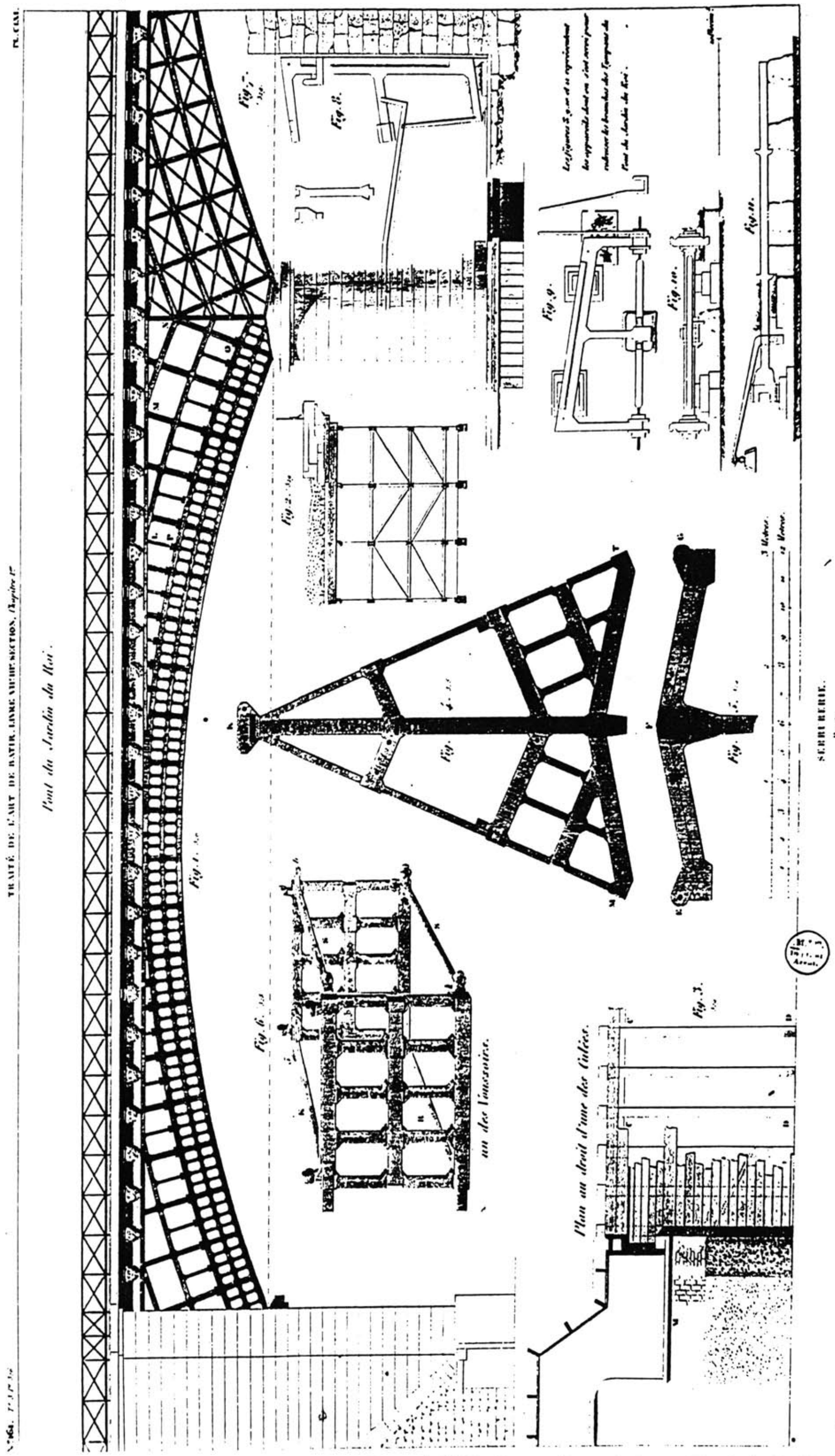
(fig. 25) Ango's beam, from A.-J.-B. Rondelet, Traité de l'art de bâtir (1802-17)



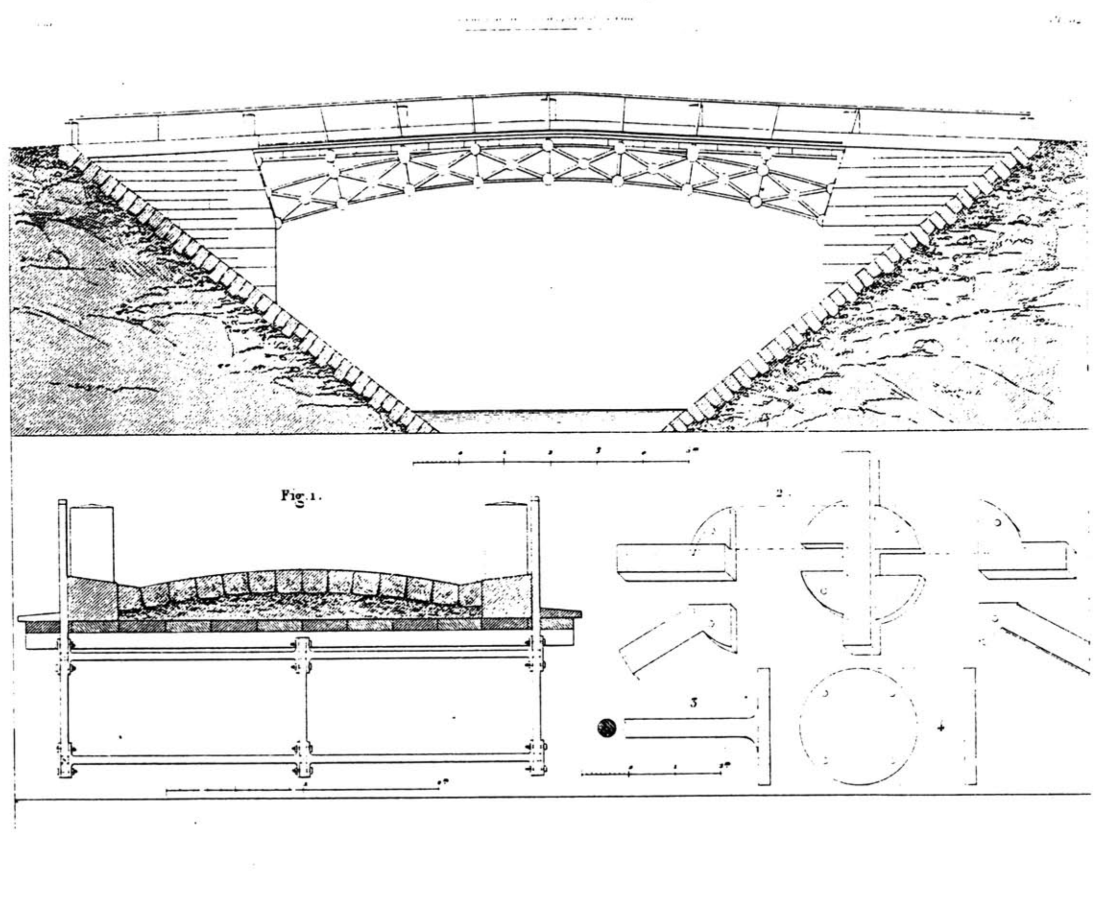
(fig. 26) Victor Louis, Théâtre Français in Bordeaux, 1786- 1789, from Ch. Eck, Traité de Construction en Pôteries et en Fer (1836-41)



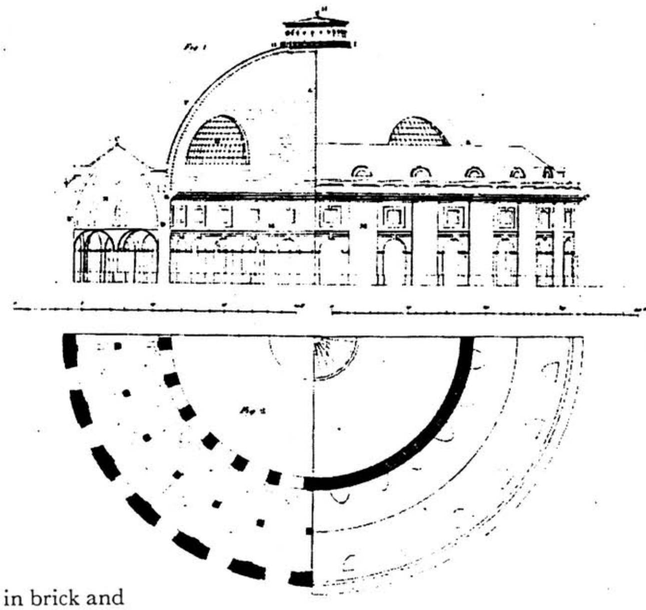
(fig. 27) Cessart, pont des arts, 1803, from Thiollet, <u>Serrurerie et Fonte de Fer</u> (1832)



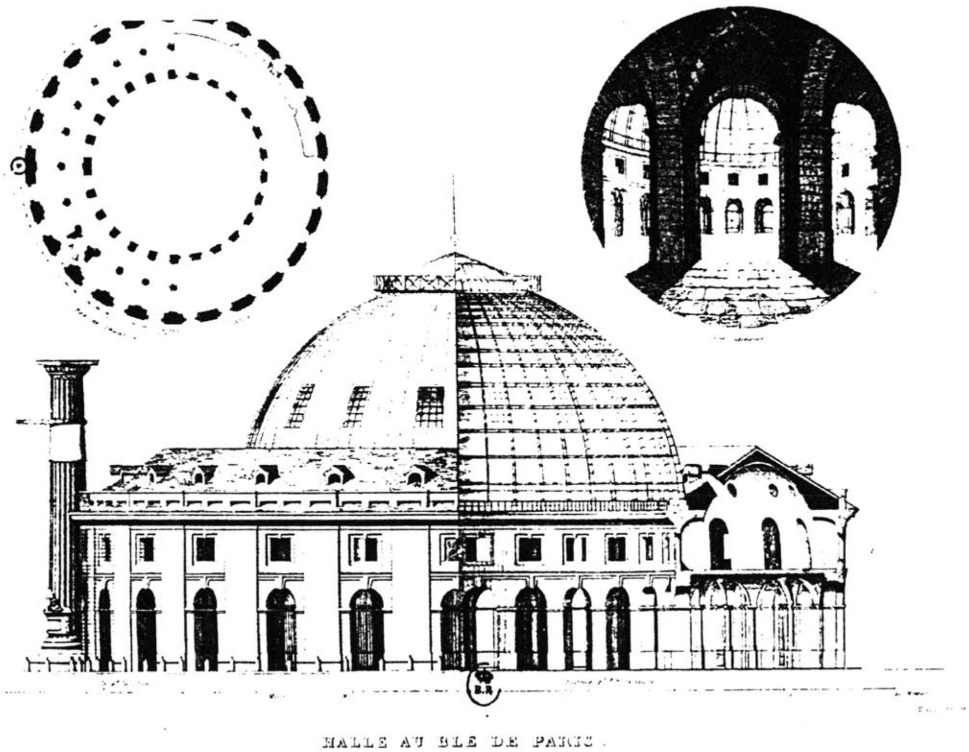
(fig. 28) Lamenadé, pont d'Austerlitz, 1806, from Rondelet, Traité de l'art de bâtir (1802-17)



(fig. 29) Louis Bruyère, wrought iron bridge at Crould, 1807, from Thiollet, Serrurerie et Fonte de Fer (1832)

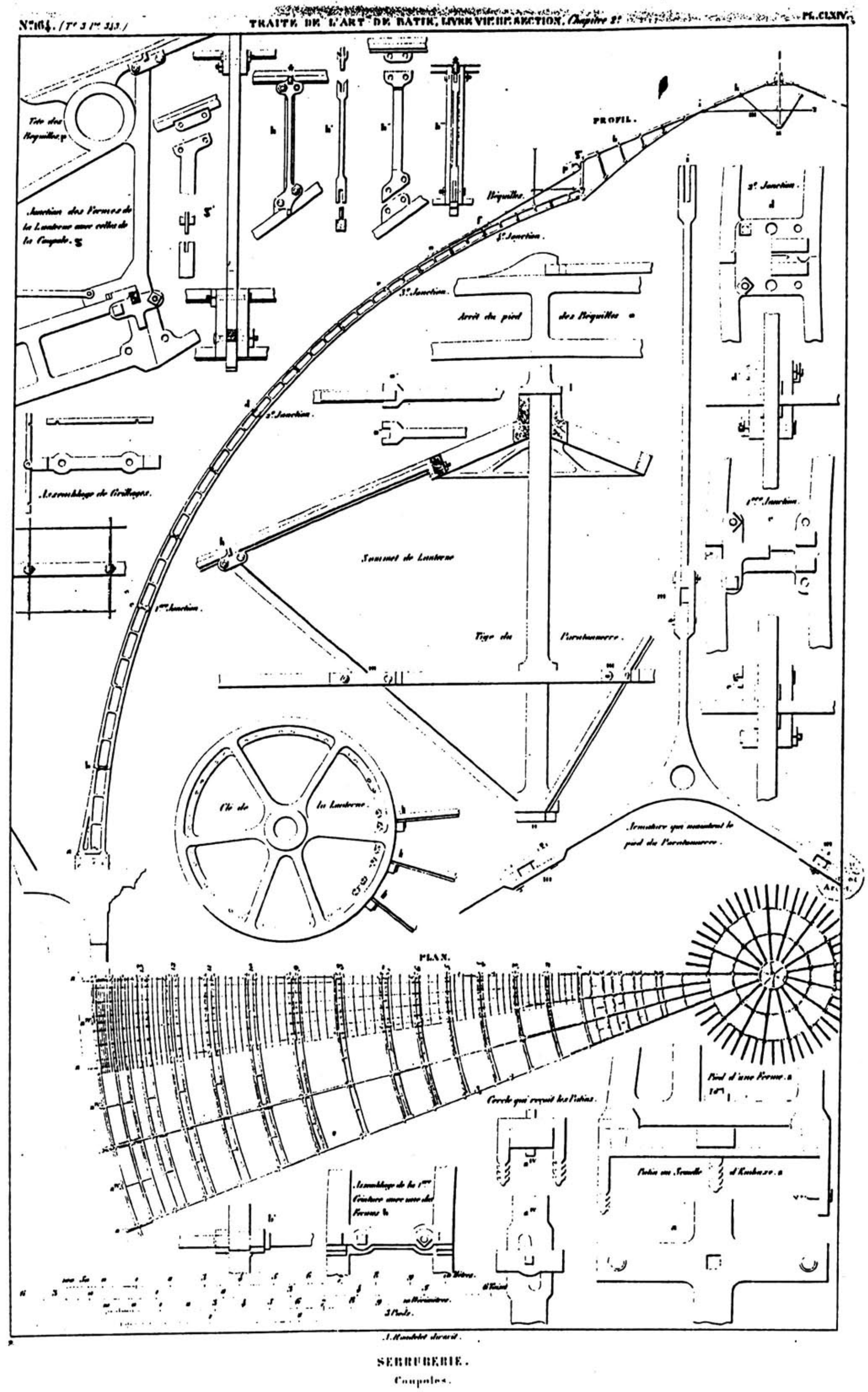


Rondelet, Projects for Halle au Blé dome in brick and
one, 1803 (from Rondelet, *Mémoire*)

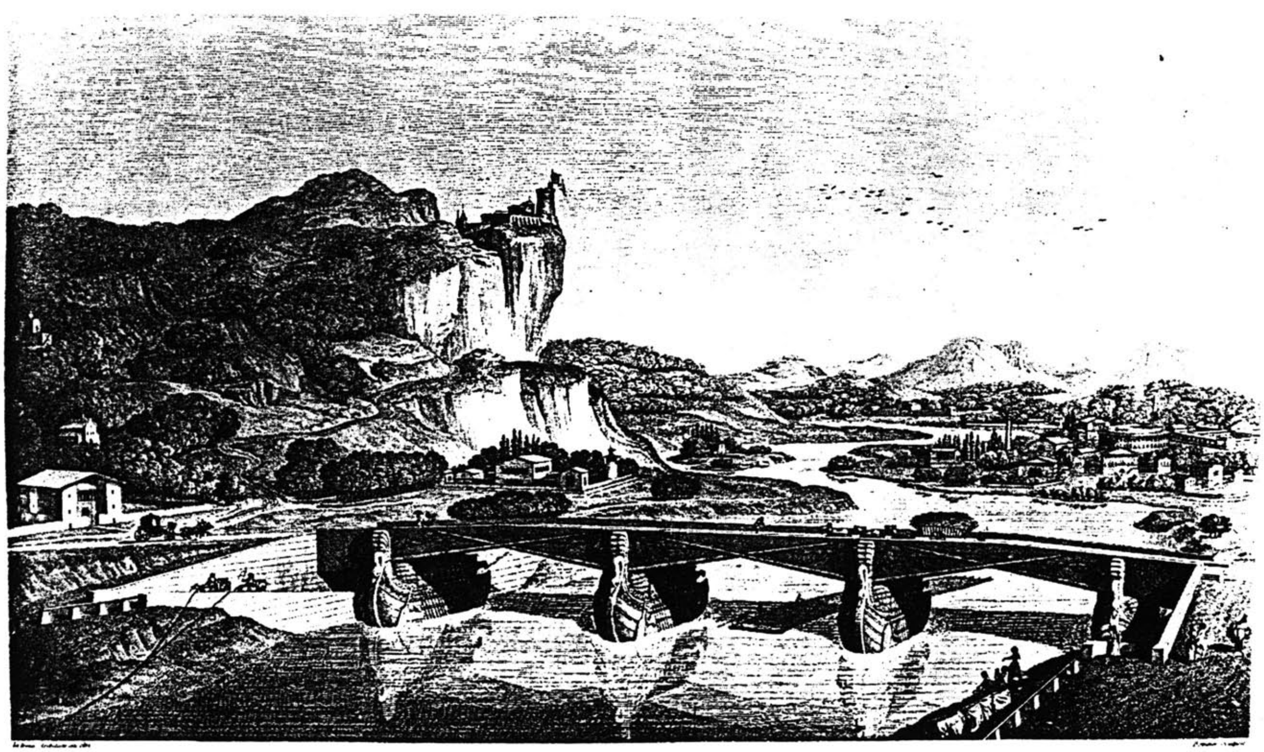


22 Plan, section, elevation and interior view, Halle au Blé (from Guilhabaud, *Monumens anciens et modernes*)

(fig. 30) Rondelet, project for Halle au Blé in brick and stone, 1803
(fig. 31) Bélanger, plan, section, elevation, and interior view, Halle au Blé, 1806-13

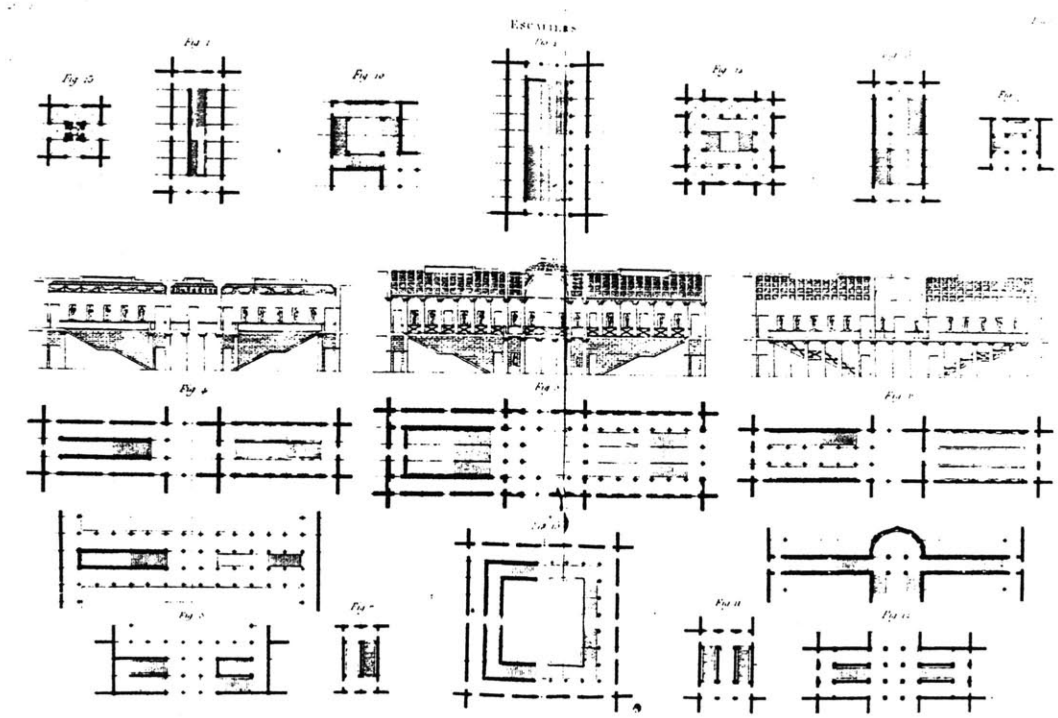


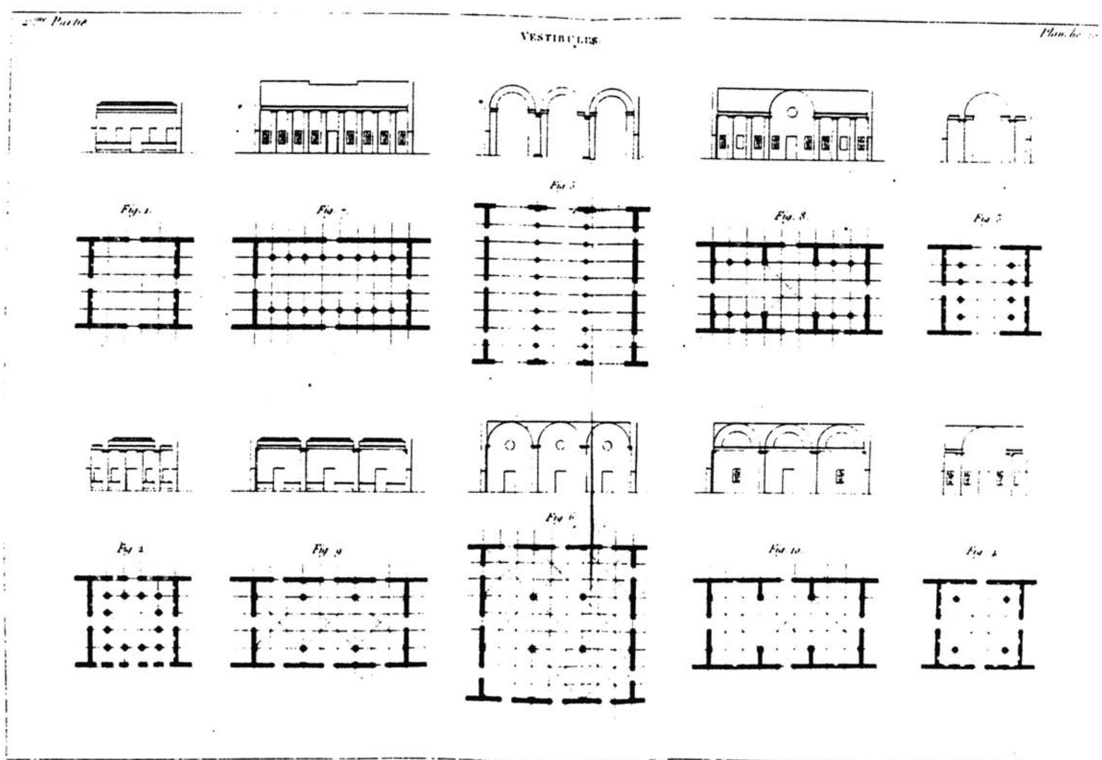
(fig. 32) Bélanger, details of the iron dome of Halle au Blé, from Rondelet, <u>Traité de l'art de bâtir</u> (1802-17)



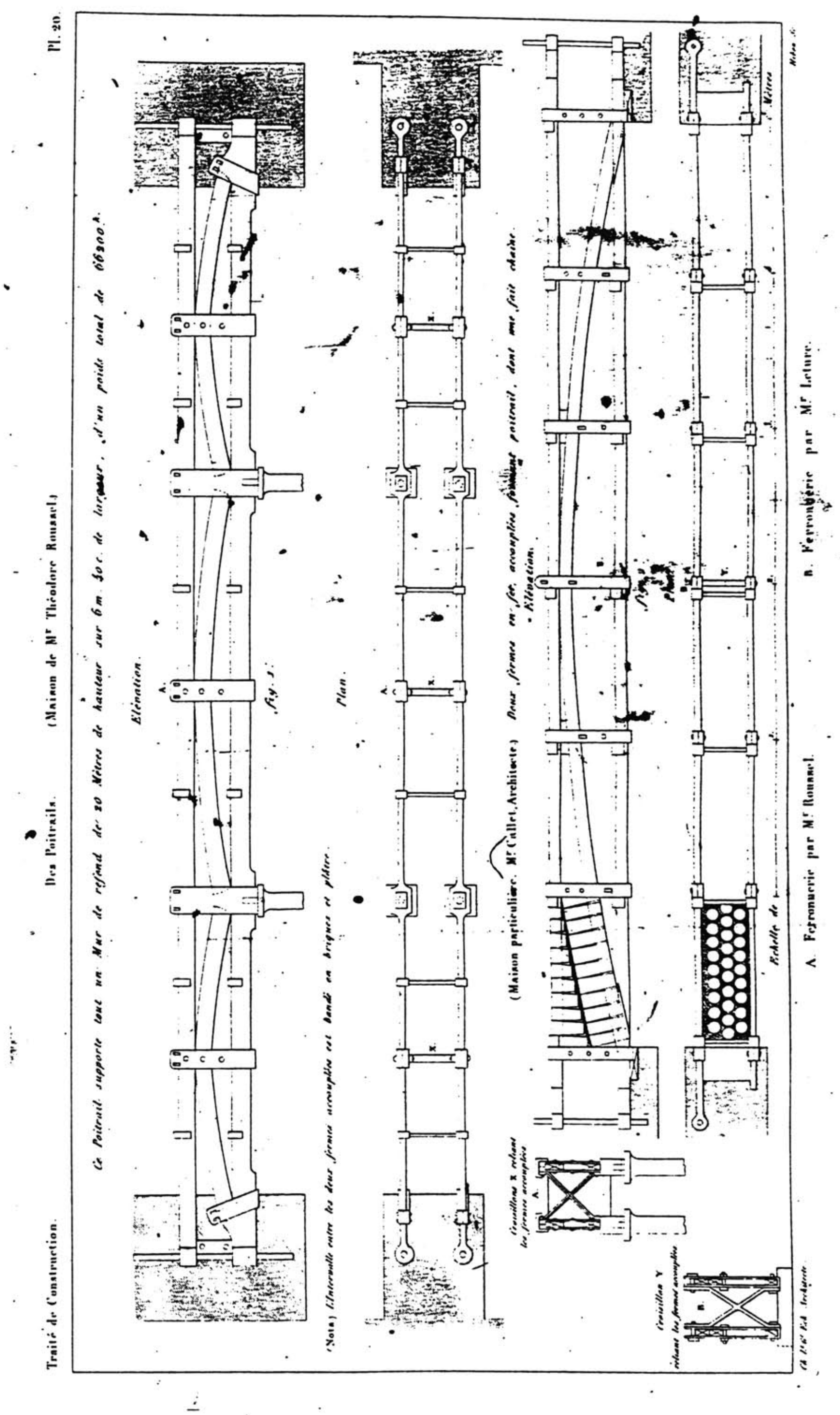
VUE PERSPECTIVE DU PONT DE LA LOUE

(fig. 33) C.-.N. Ledoux, Perspective view of Loüe bridge, Architecture (1804)

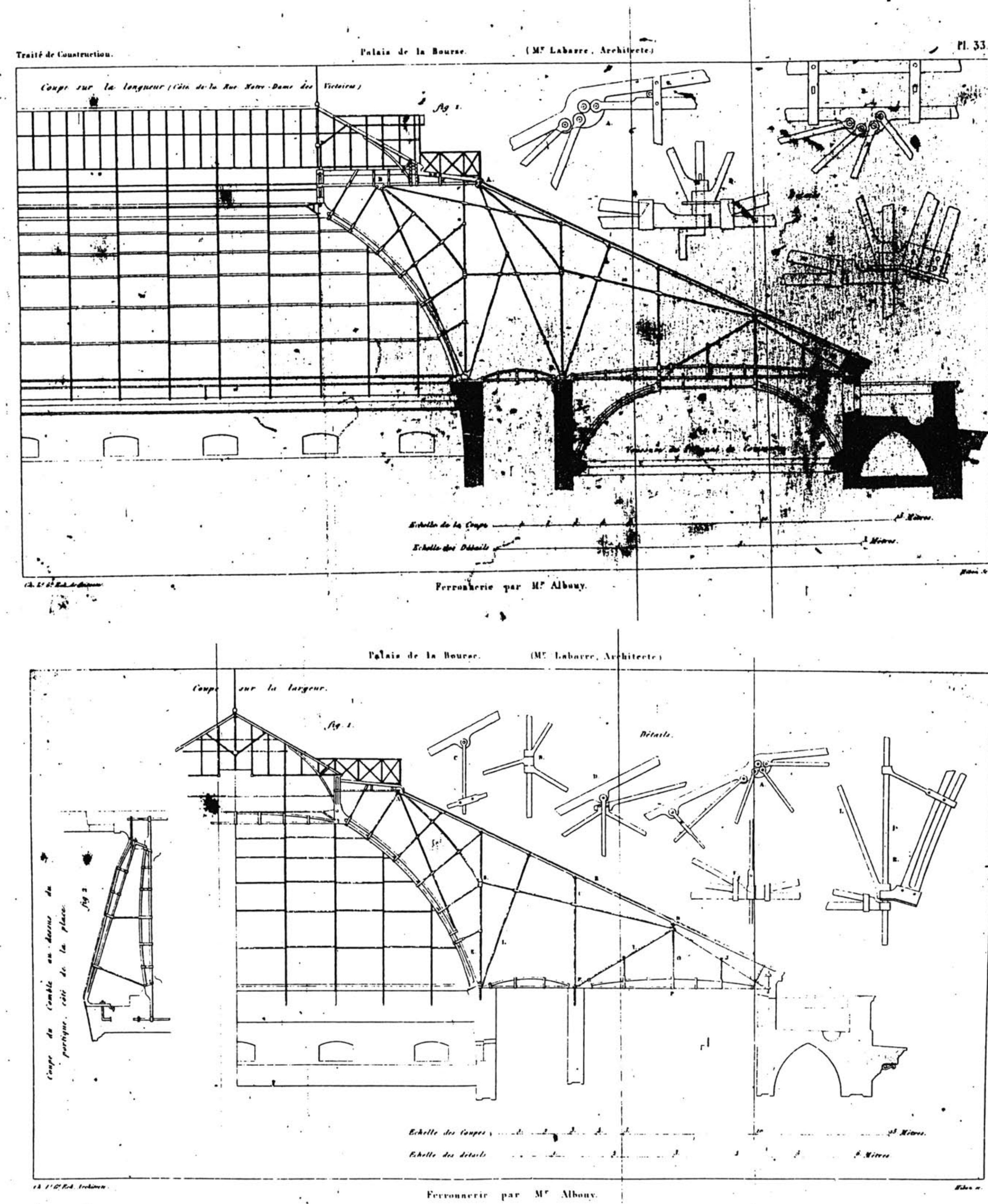




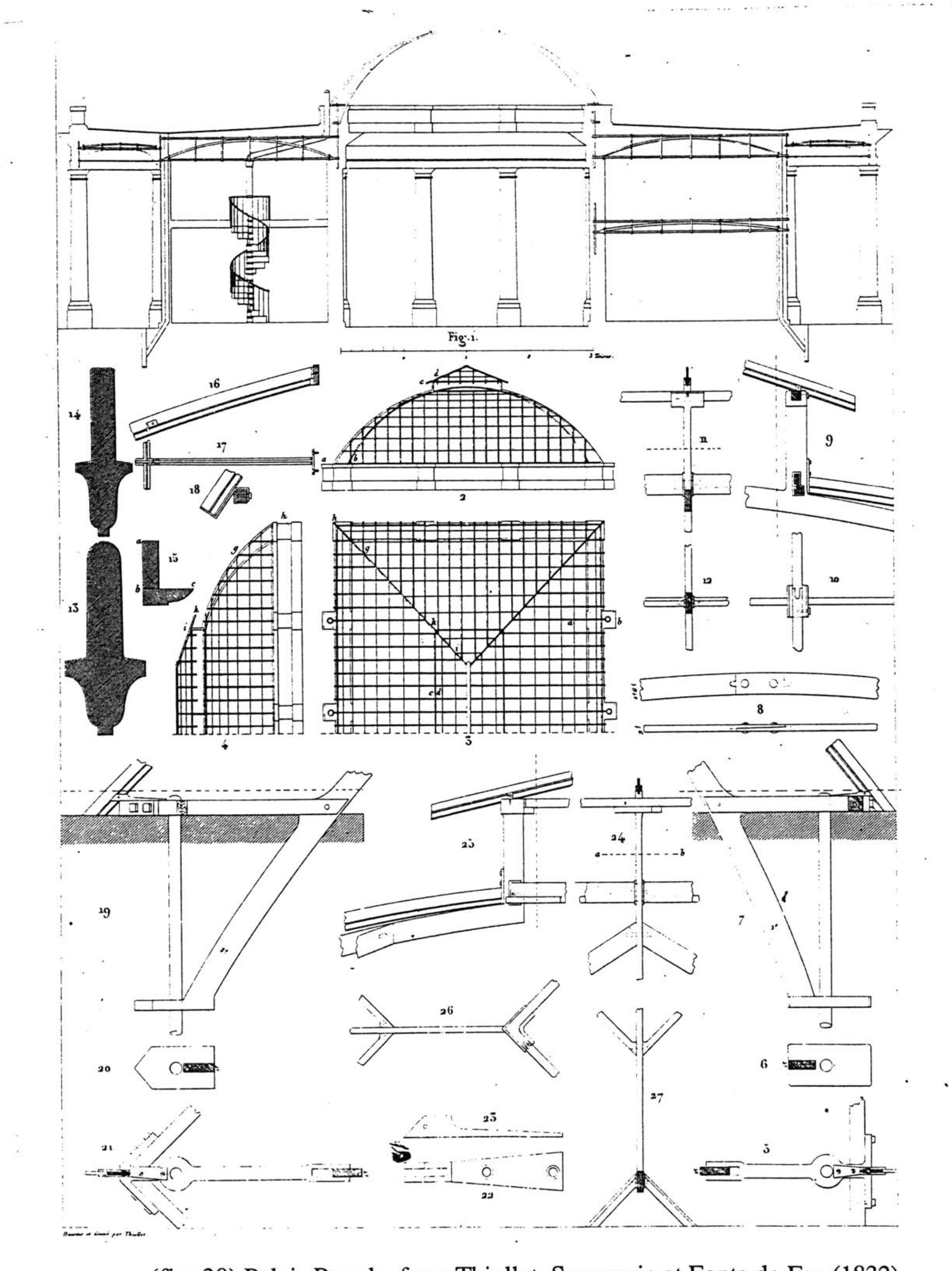
(fig. 34).J.N.L. Durand, parts of building: Staircases, Précis des Leçons d'architecture
(fig. 35) J.N.L. Durand, parts of building: Vestibules, Précis des Leçons d'architecture



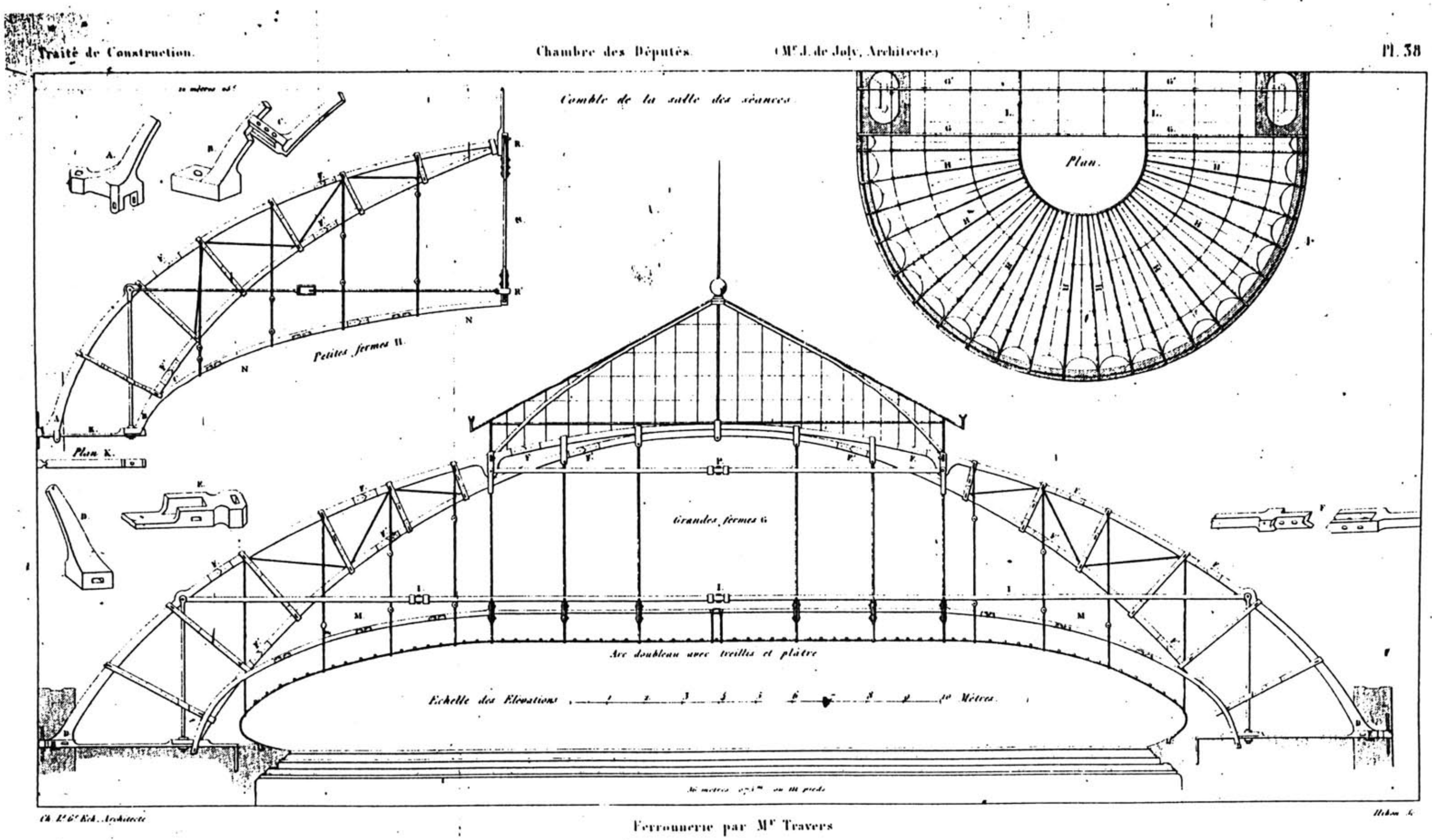
(fig. 36) Example of Ango's beam with hollow pots as a fireproof construction, from Ch. Eck, Traité de Construction en Pôteries et en Fer (1836-41)



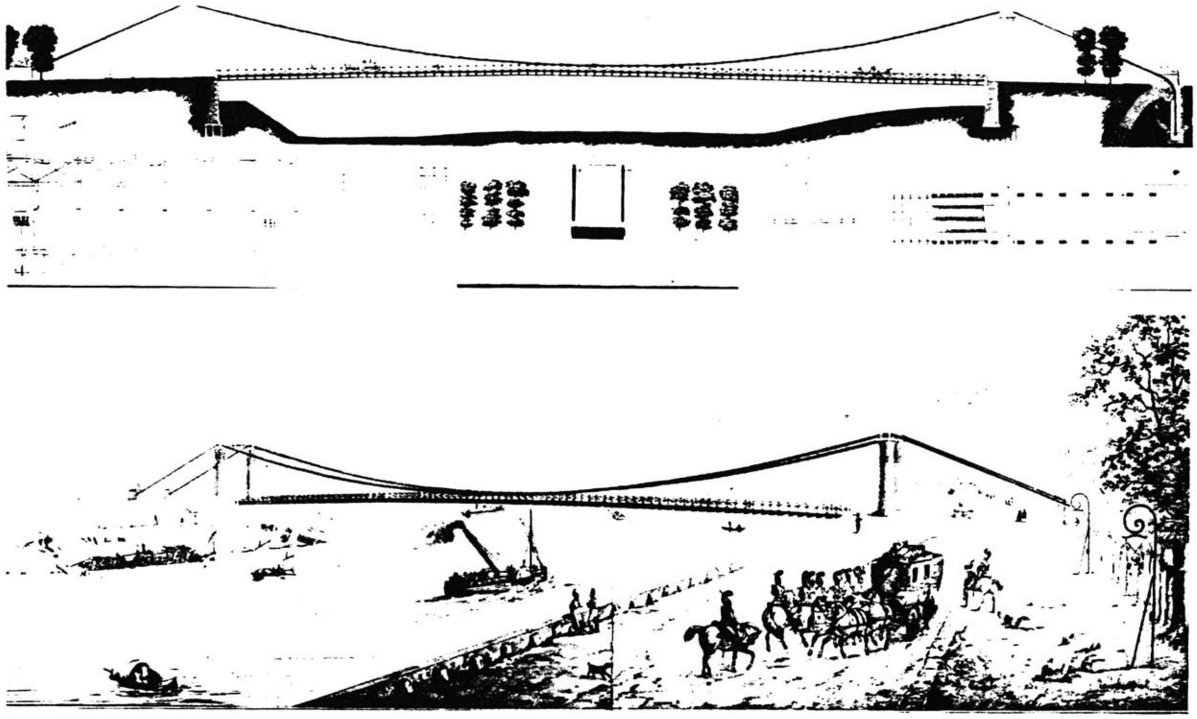
(fig. 37) Labarre, Palais de la Brouse, from Eck, <u>Traité de Construction en Pôteries et en Fer</u> (1836-41)

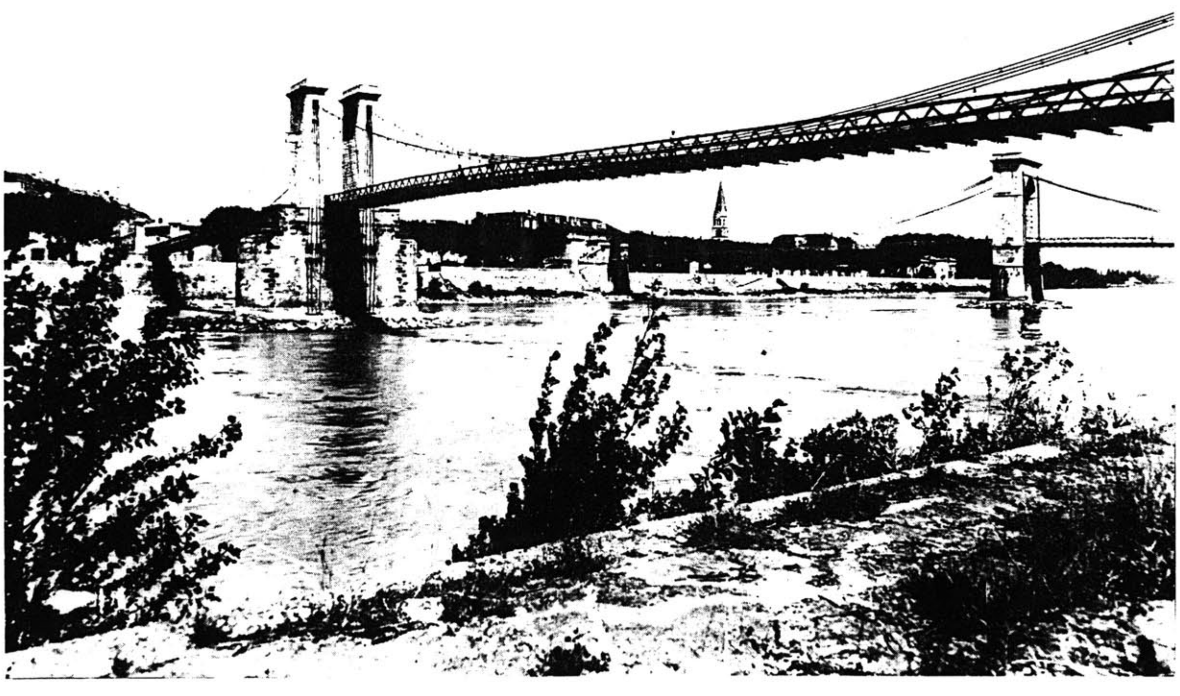


(fig. 38) Palais Royale, from Thiollet, <u>Serrurerie et Fonte de Fer</u> (1832)



(fig. 39) Chamber of Deputies, from Eck, Traité de Construction en Poteries et en Fer, (1836-41)





(fig. 40) Navier, project for pont des Invalides, 1823
(fig. 41) Seguin, suspension bridge at Tournon over the Rhône, 1824

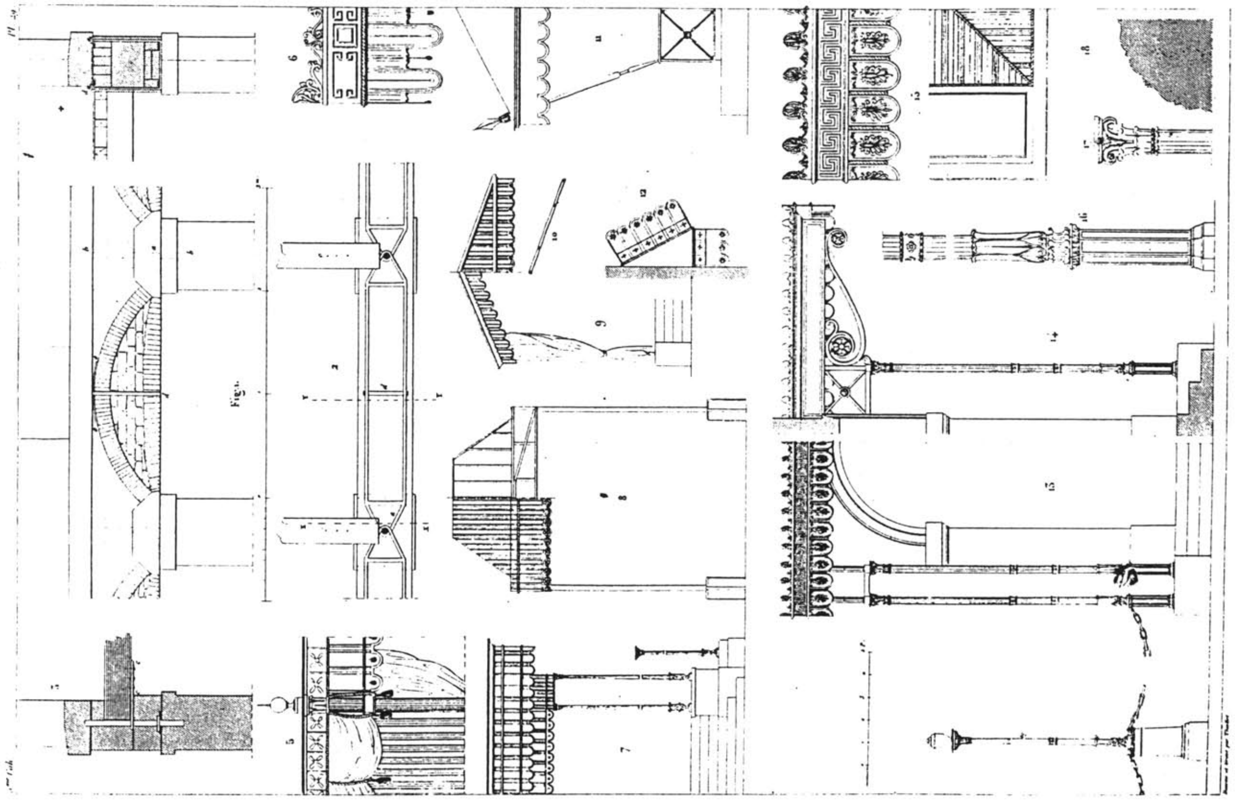
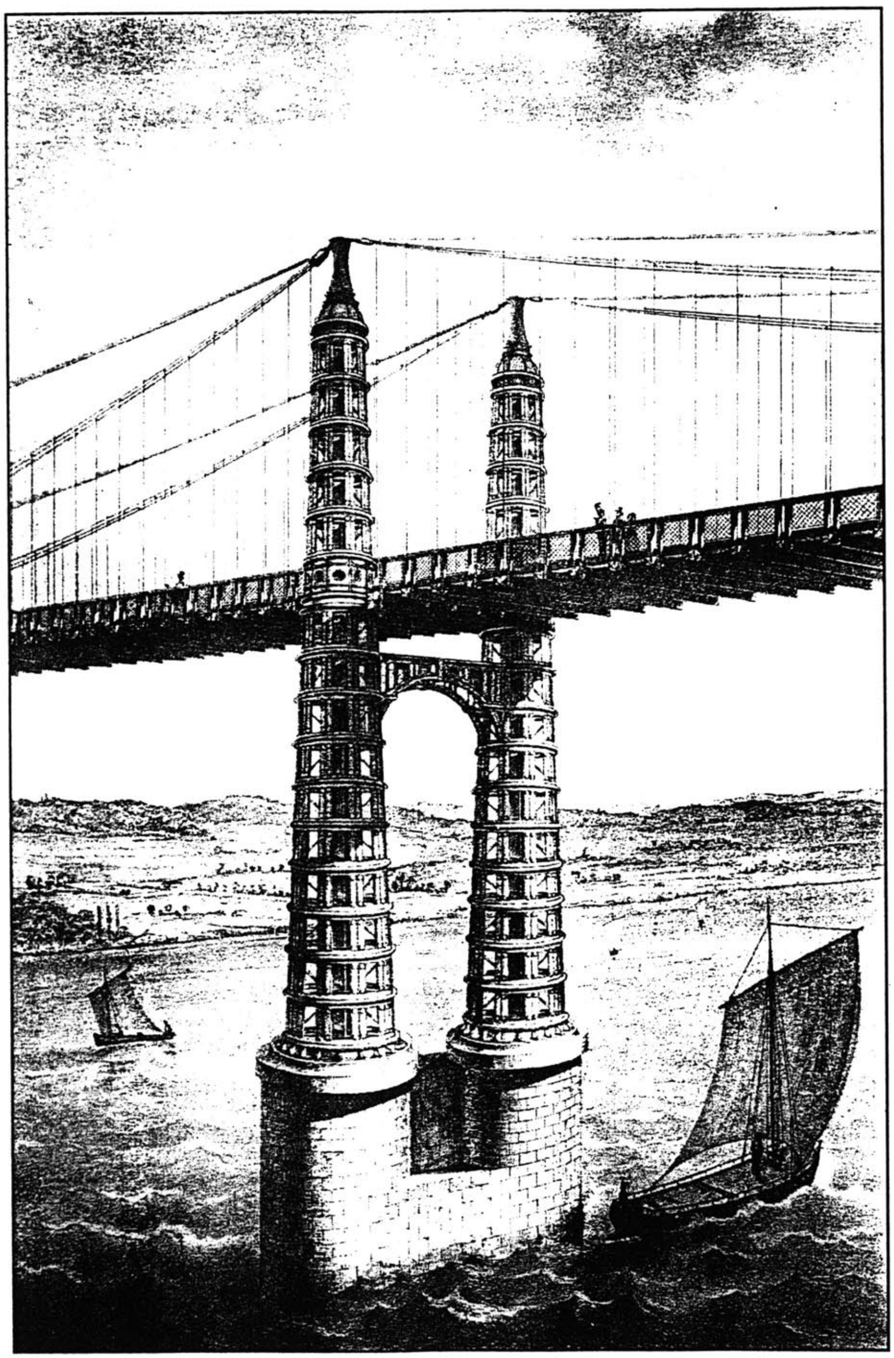
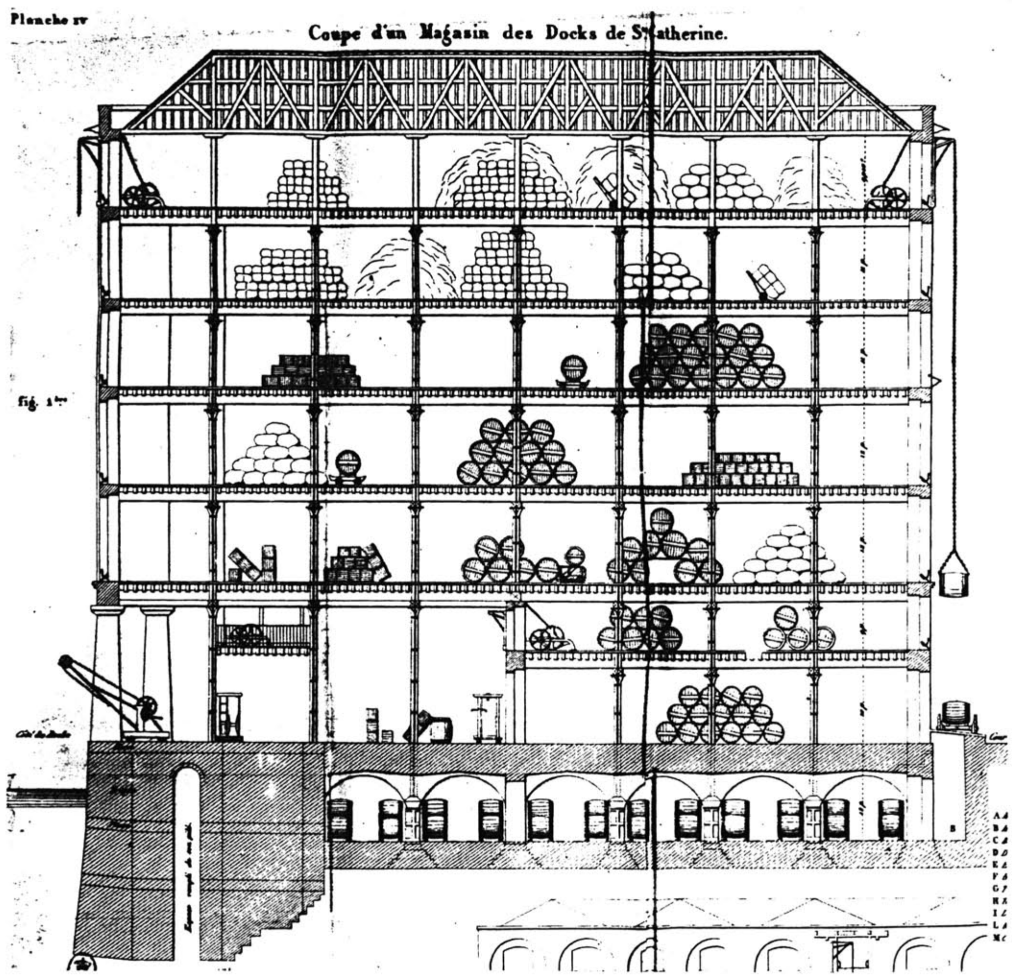


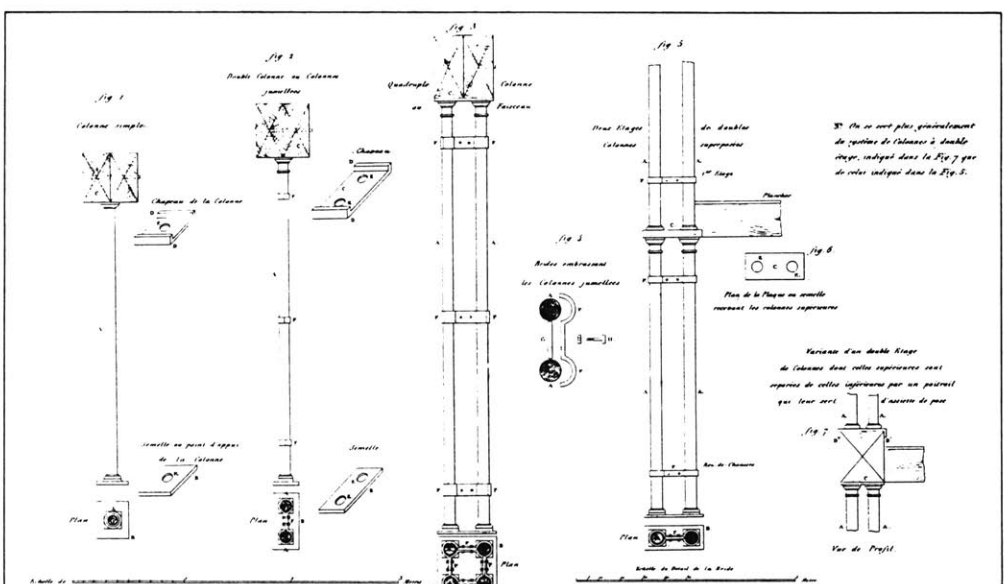
FIG. 108. — HERVAS. PARIS. MAGASIN DU GRAND COLBERT.

(fig. 42) Example of shop with iron, from Thiollet, Serrurerie et Fonte de Fer (1832)
(fig. 43) Hervas, Magasin du Grand Colbert

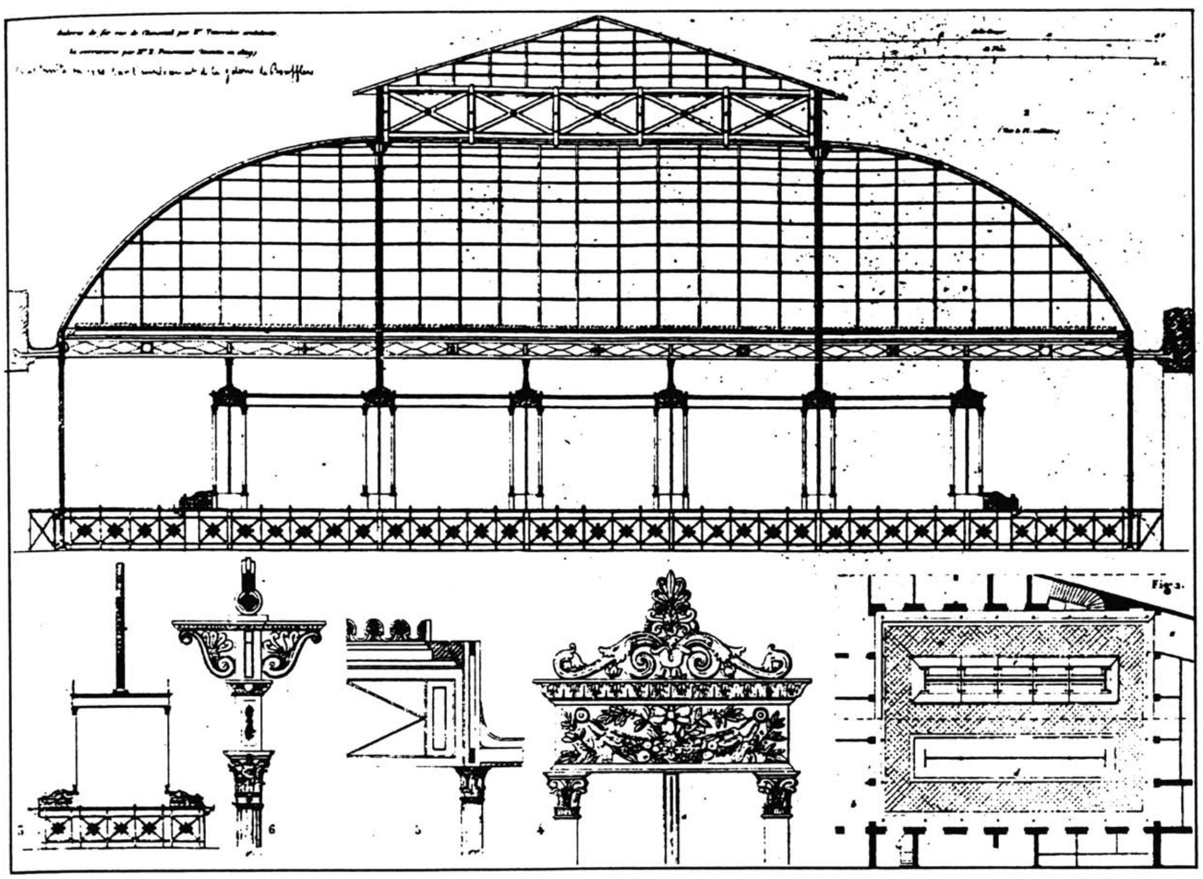


(fig. 44) Emile Matin, pont de Cubzac, 1833

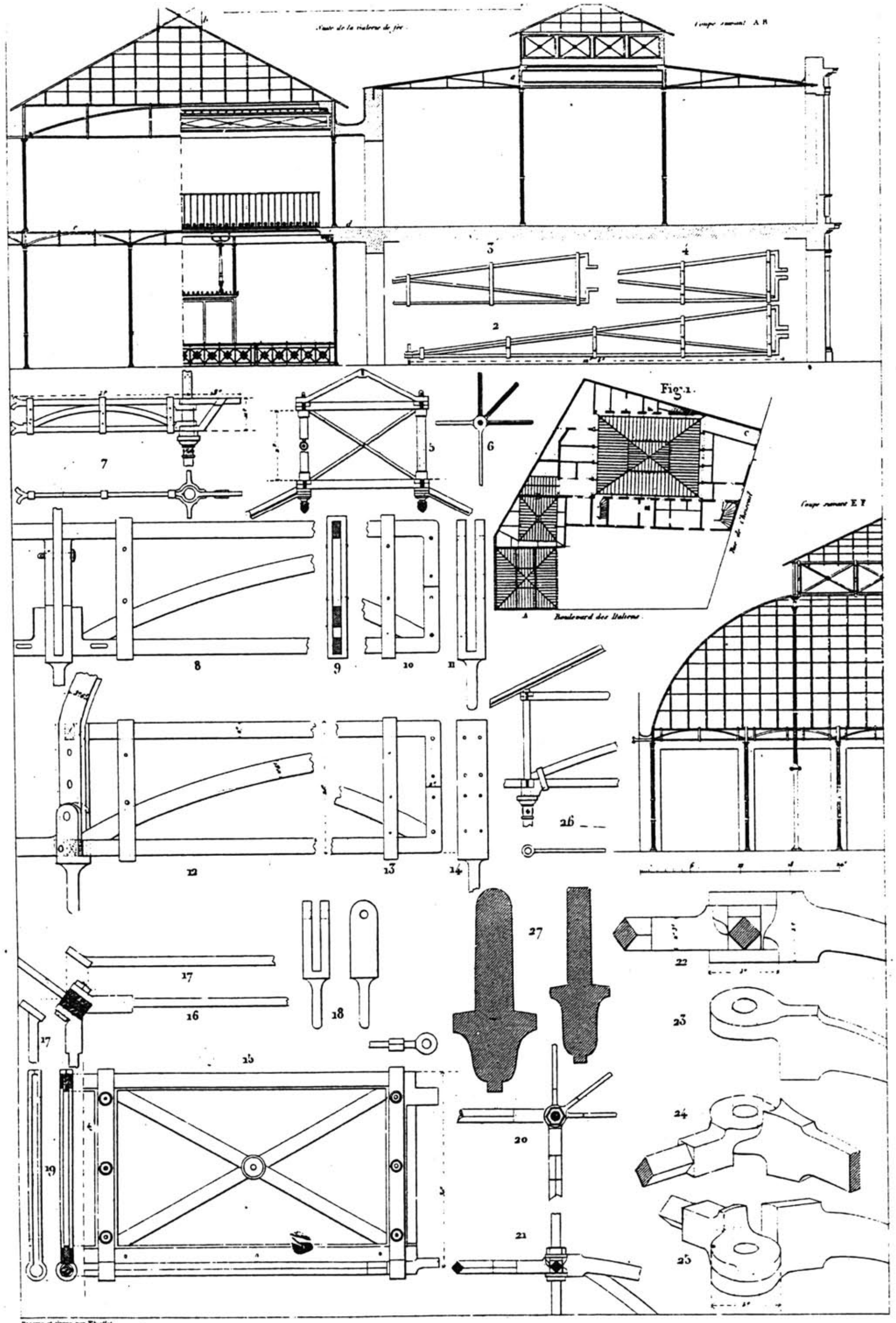




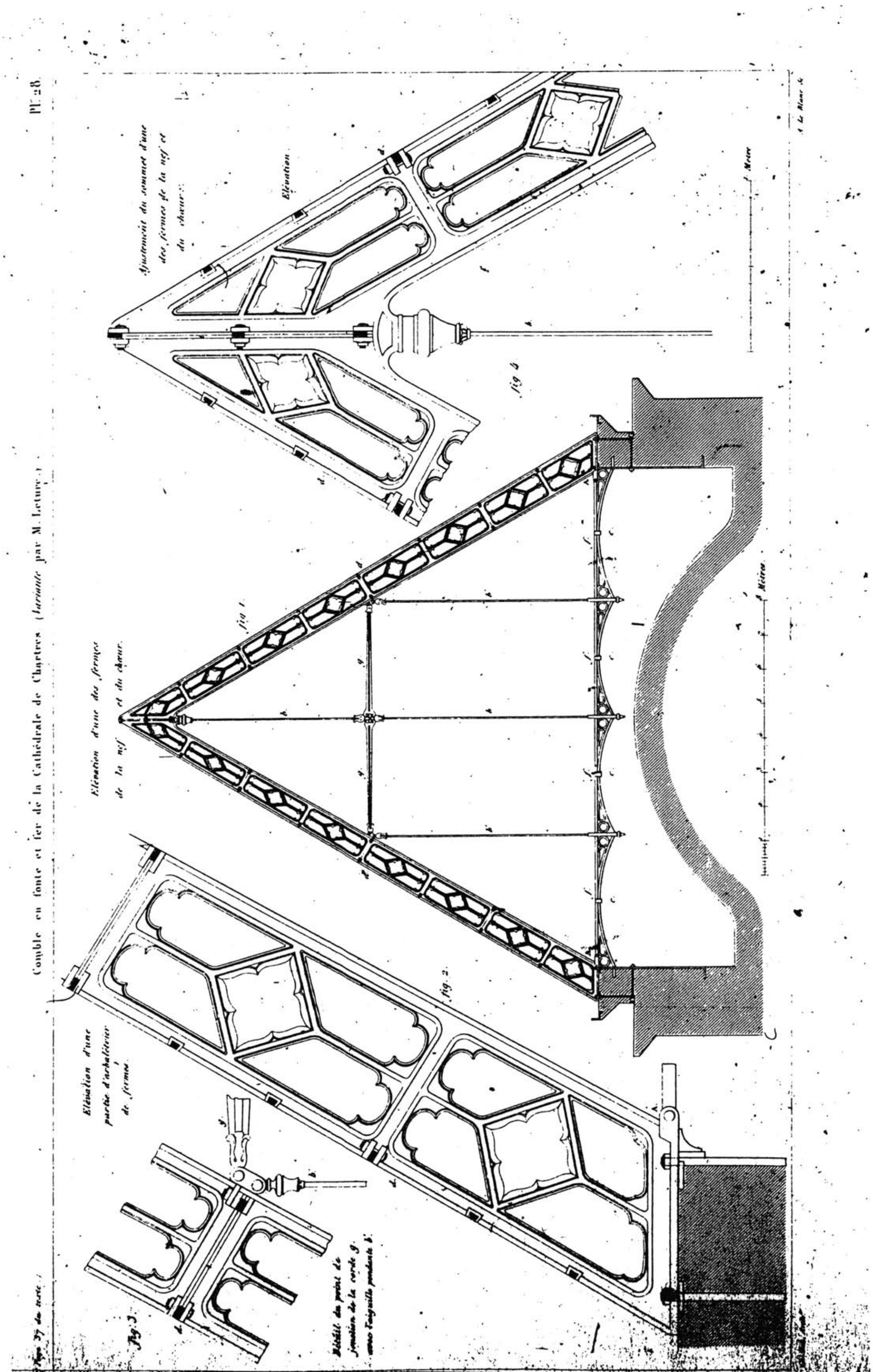
(fig. 45) Example of cast iron multi-story building, Sainte-Catherine docks, London, 1827



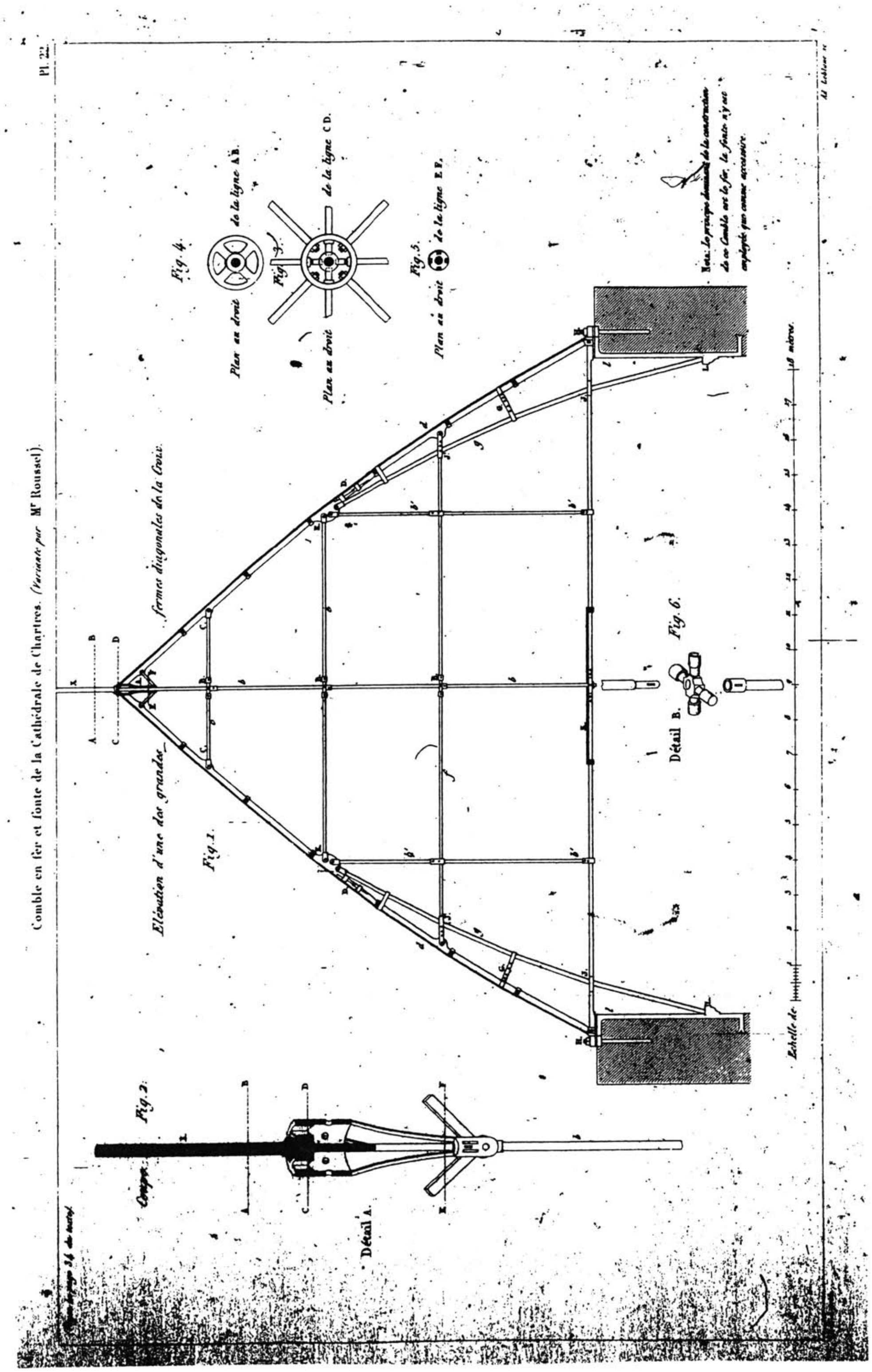
(fig. 46) Travenier, Galerie de fer, 1829



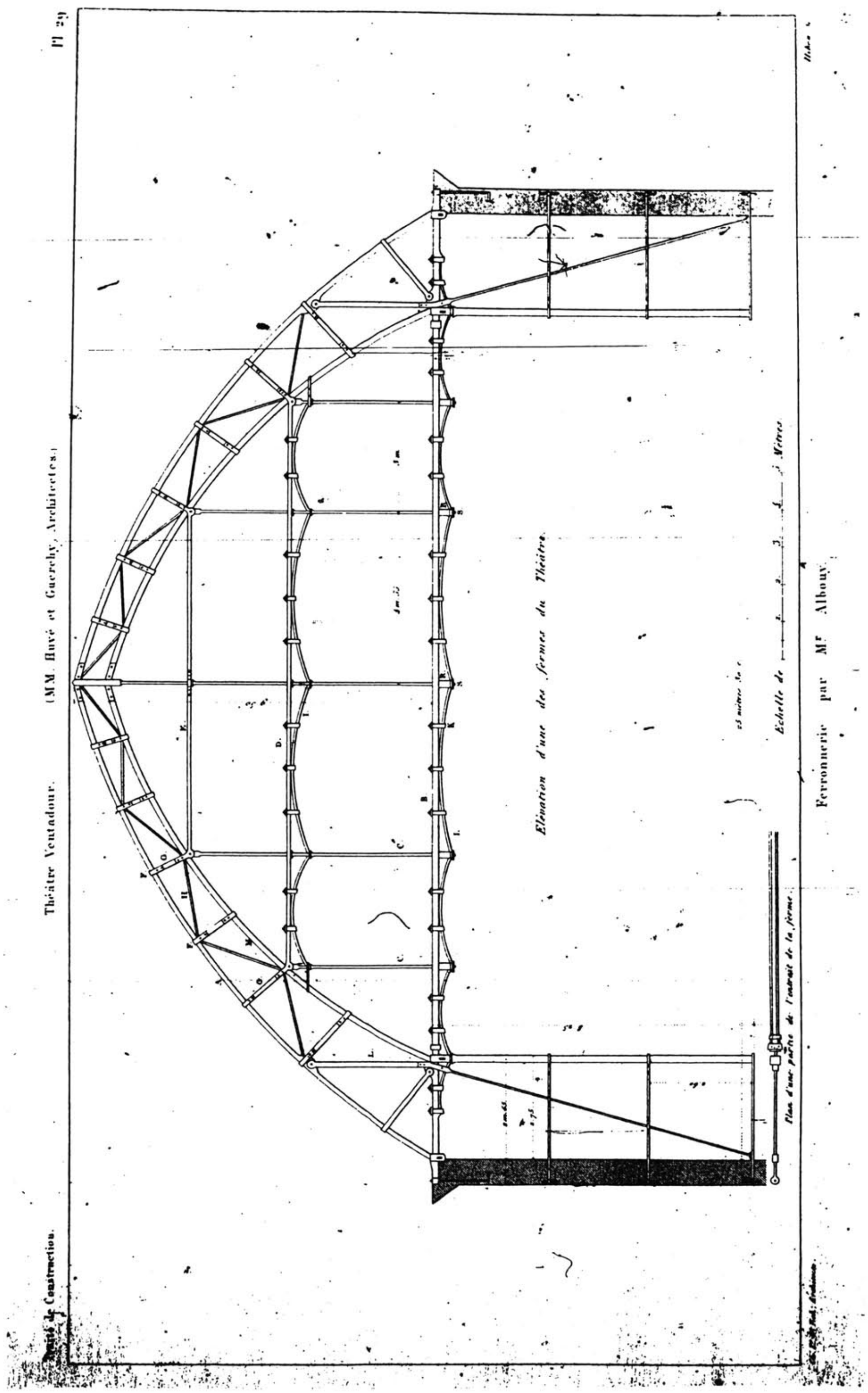
(fig. 47) Travenier, Galerie de fer, 1829, from Thiollet, Serrurerie et Fonte de Fer (1832)



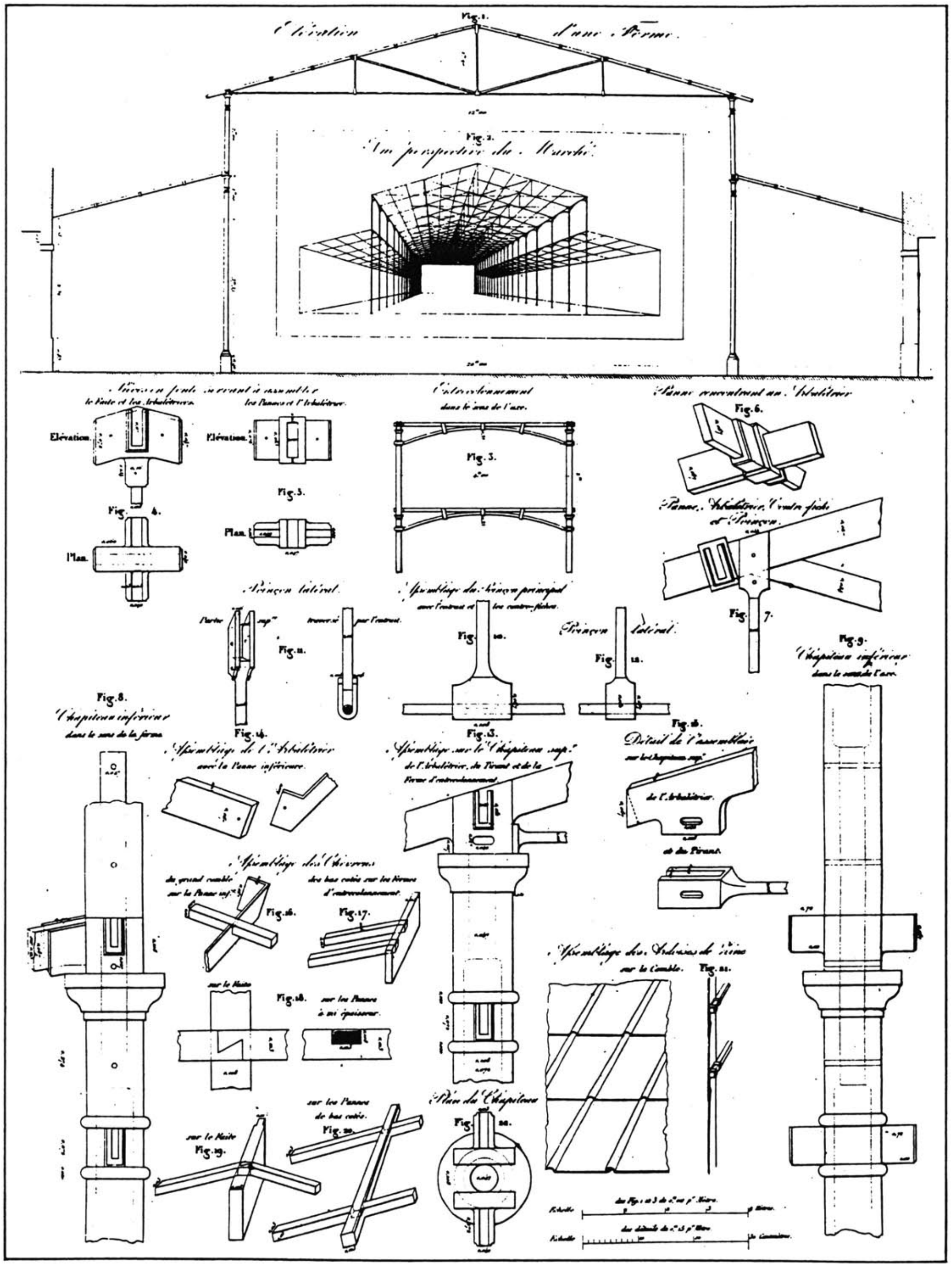
(fig. 48) Leturc, projects for the iron lantern of the cathedral of Chartres, 1836, from Eck, Traité de Construction en Pôteries et en Fer (1836-41)



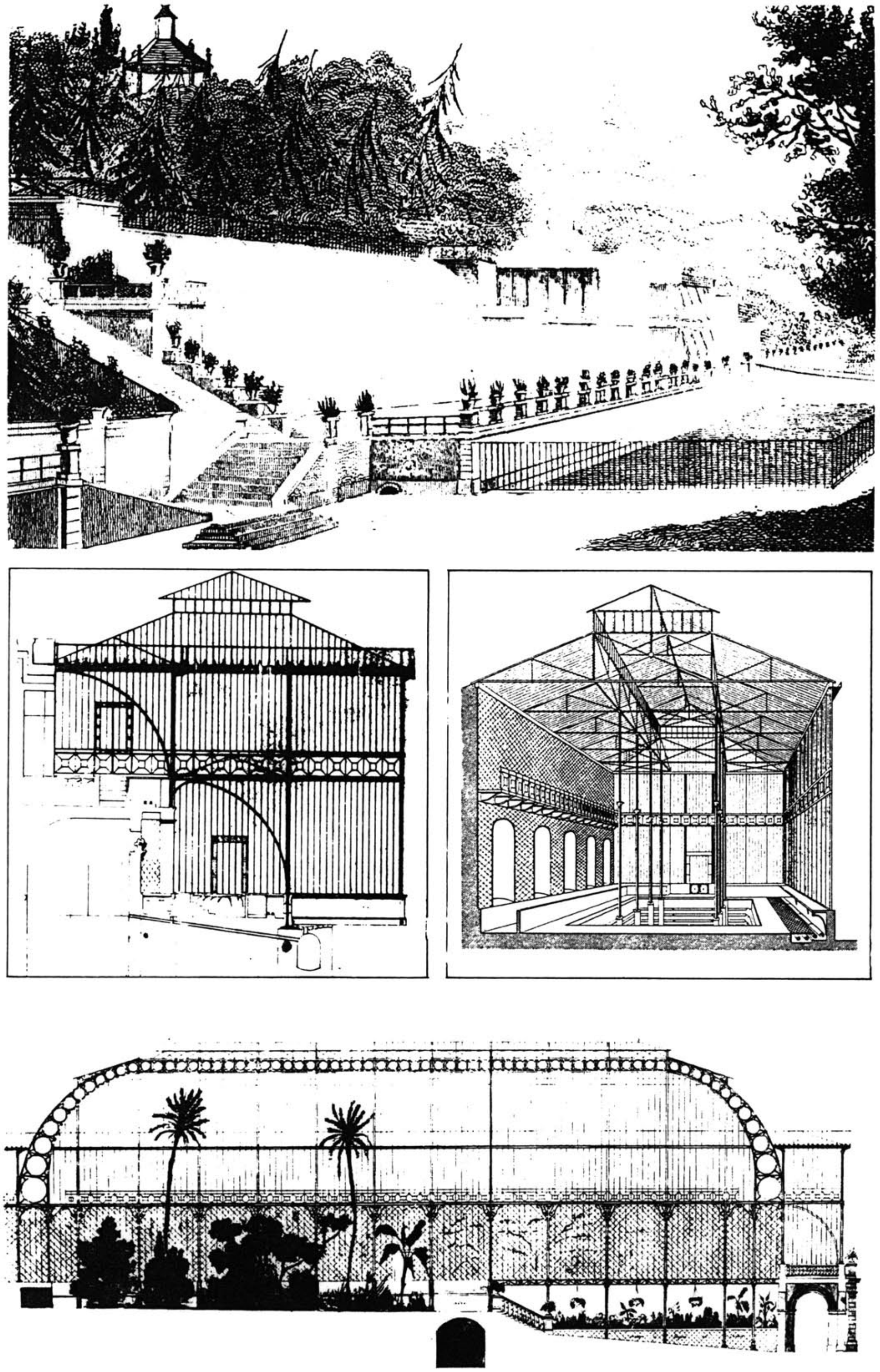
(fig. 49) Roussel, Projects for the iron lantern of the cathedral of Chartres, 1836, from Eck, Traité de Construction en Pôteries et en Fer (1836-41)



(fig. 50) Martin and Mignon, Projects for the iron lantern of the cathedral of Chartres, 1836, from Eck, <u>Traité de Construction en Pôteries et en Fer</u> (1836-41)

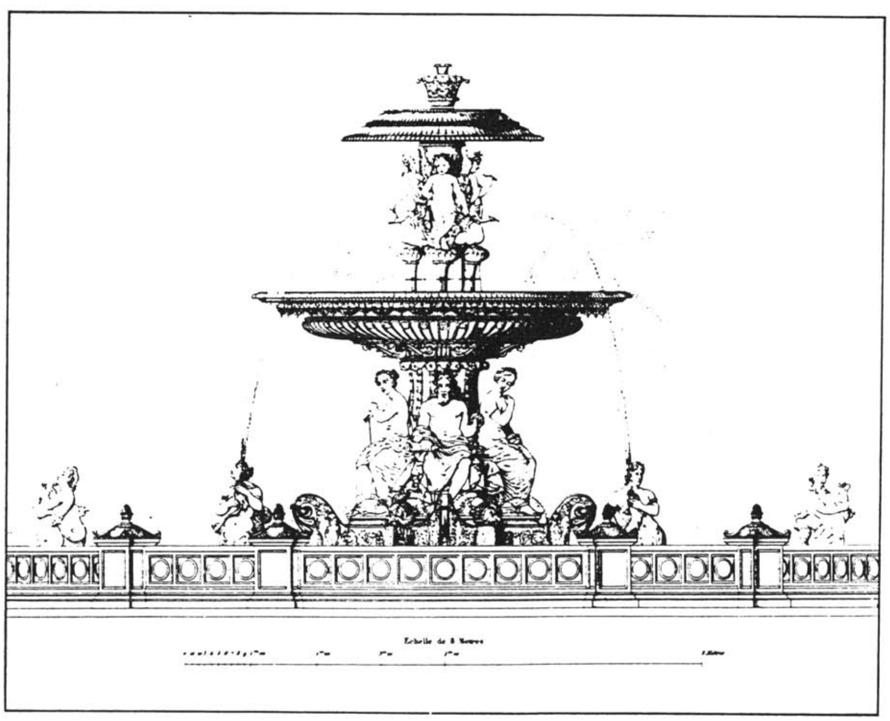


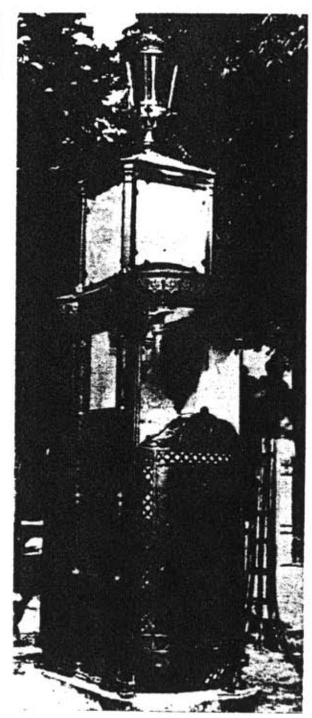
(fig. 51) Veugny, Madeleine market hall, 1828



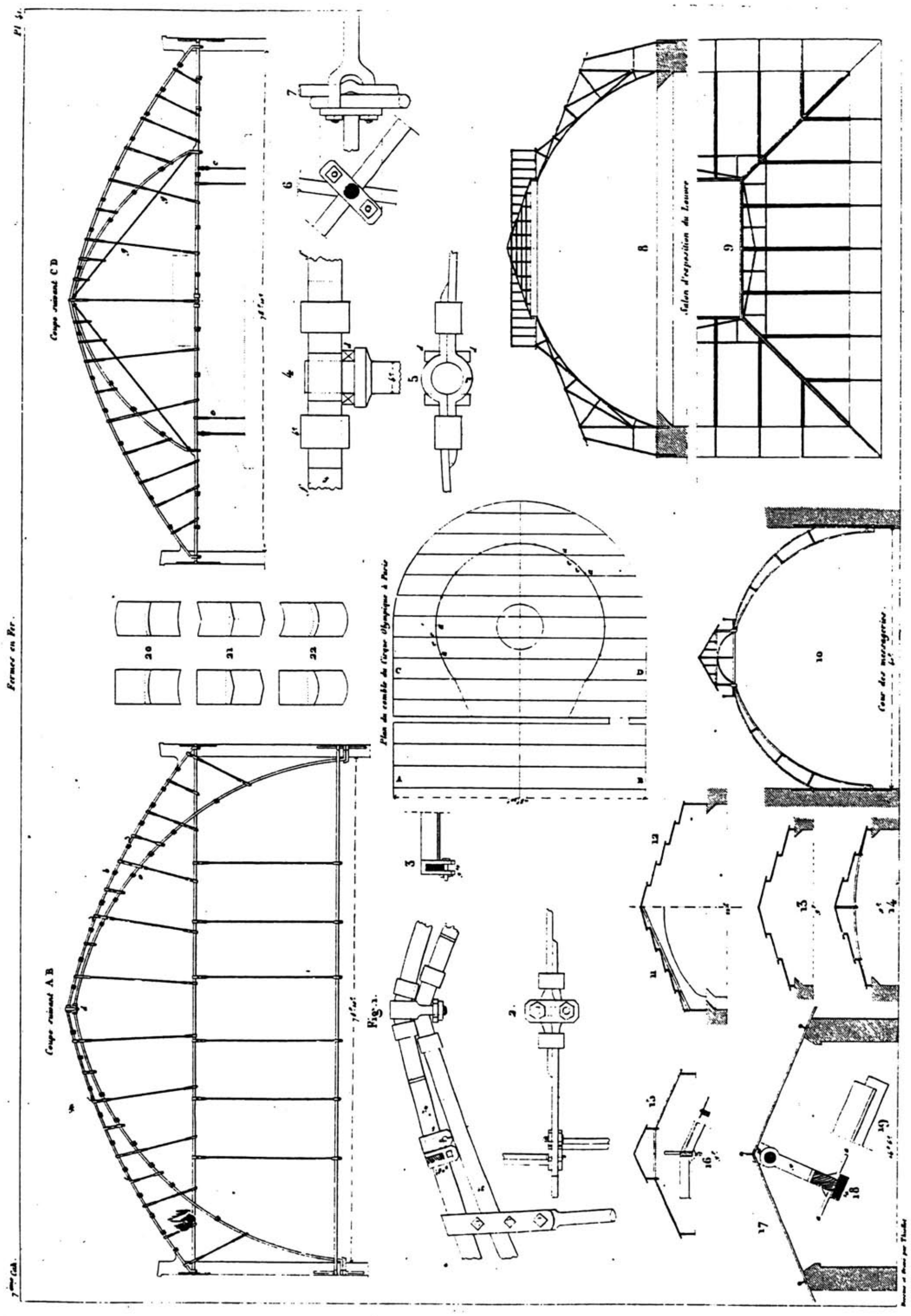
(fig. 52) Ch. Rouhault, jardin d'hiver, 1833

Fig. 203. — HITTORF. PARIS. CAFÉS DES CHAMPS-ÉLYSÉES.

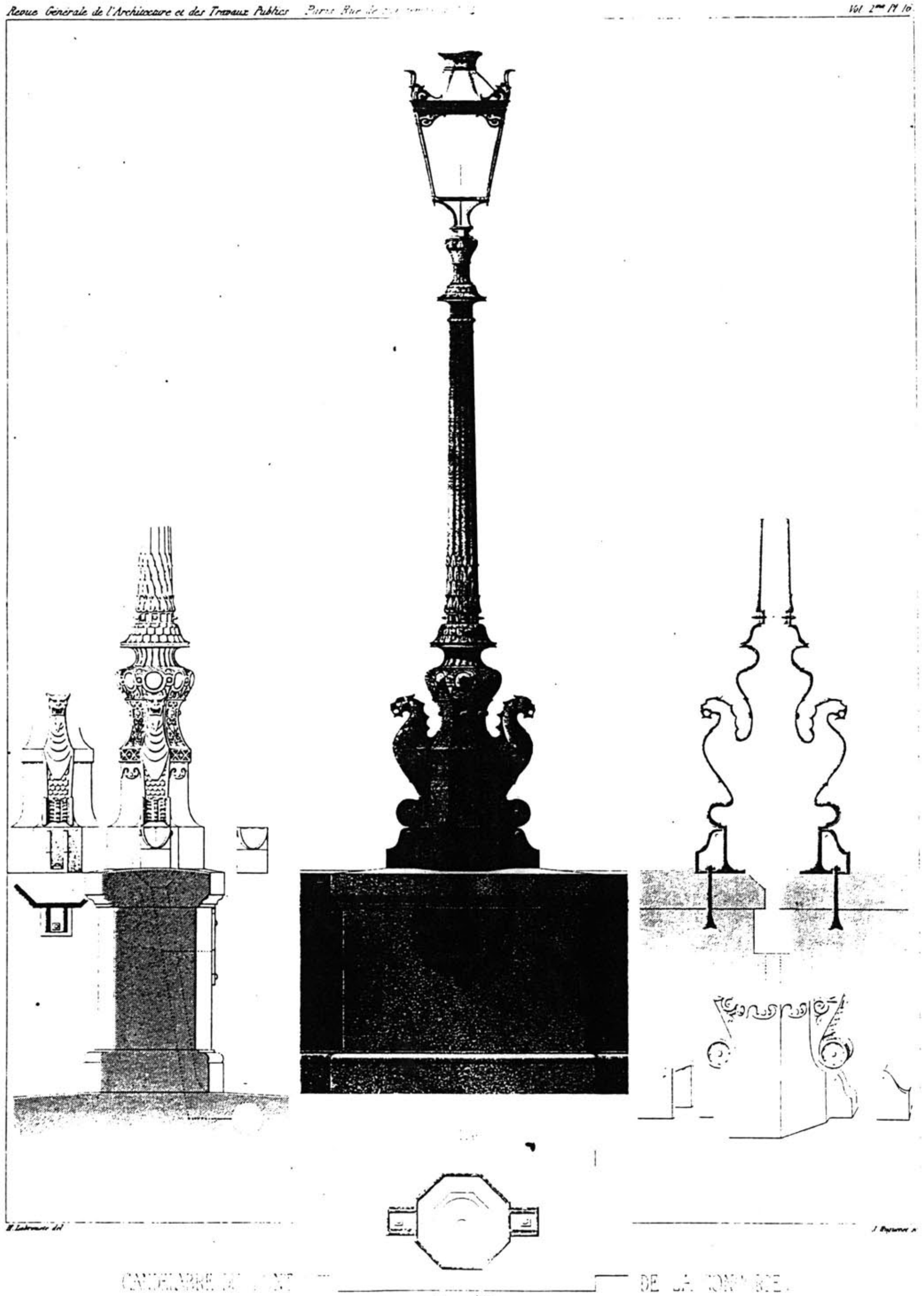




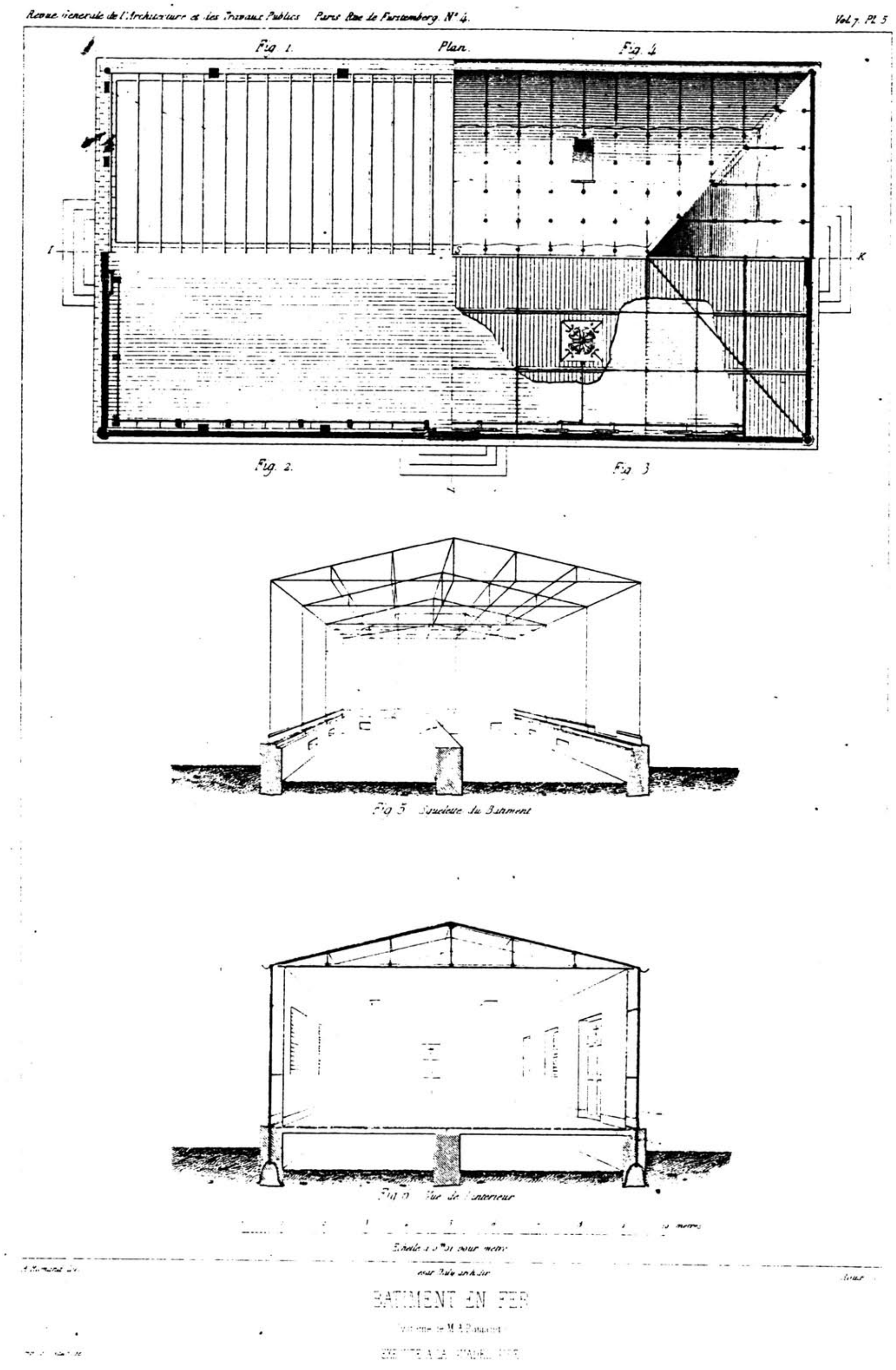
(fig. 53) J. Hittorff, cafés in the Champs Elysées
(fig. 54) J. Hittorff, cast iron fountain in la Place de la Concorde, 1836



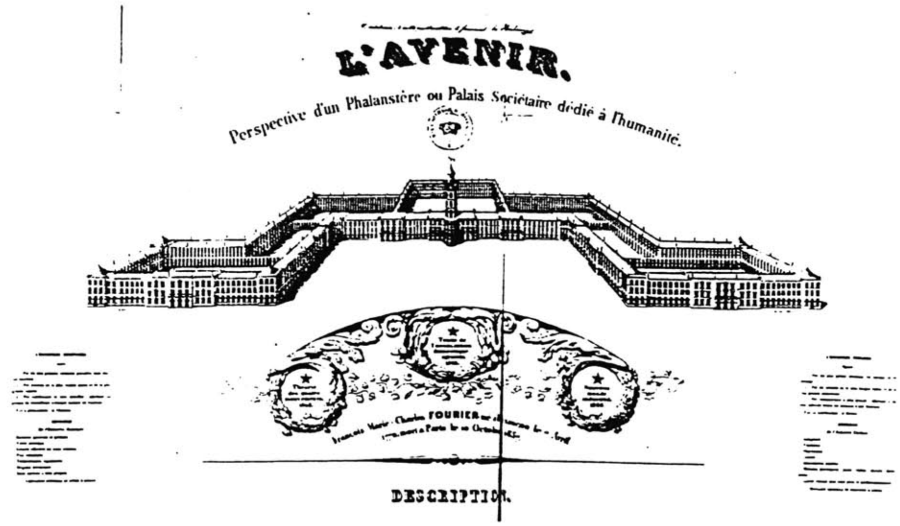
(fig. 55) J. Hittorff, Theater of ambique-comique, 1828, from Thiollet, Thiollet, <u>Serrurerie et Fonte de Fer</u> (1832)



(fig. 56) Hittorff, cast iron lamp in la Place de la Concorde, Revue Générale de l'architecture (1841)

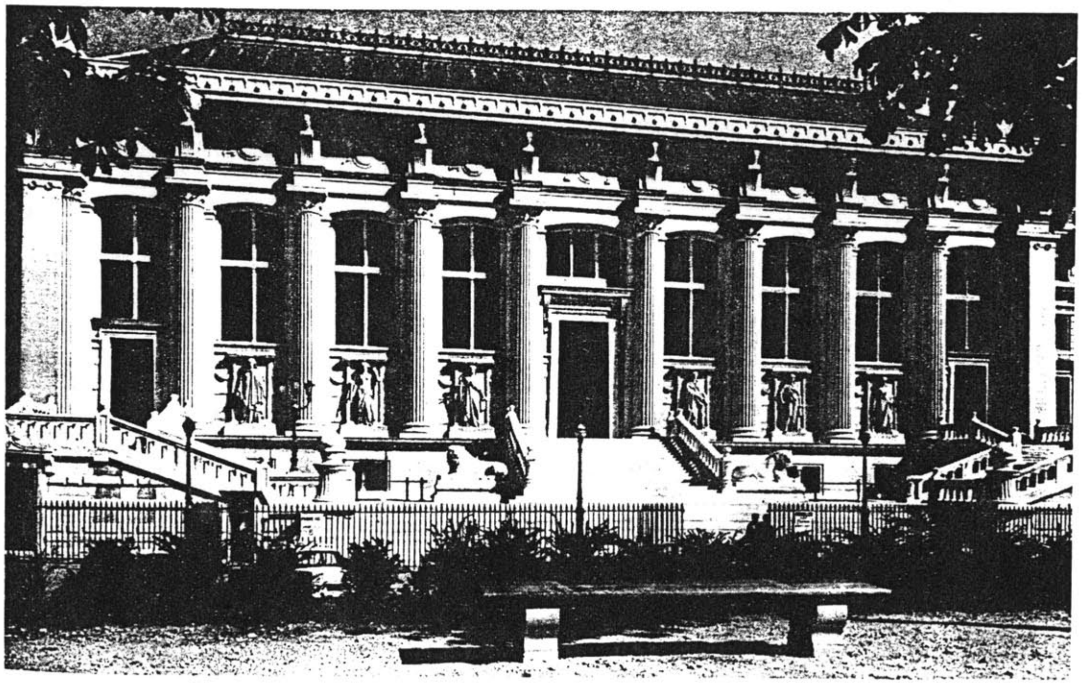


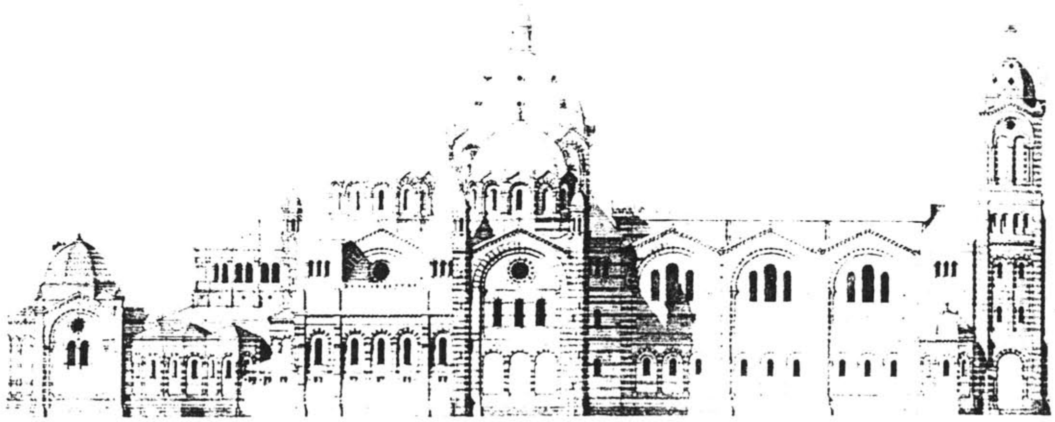
(fig. 57) A. Romand, iron hospital, 1847, <u>Revue Générale de l'architecture</u>



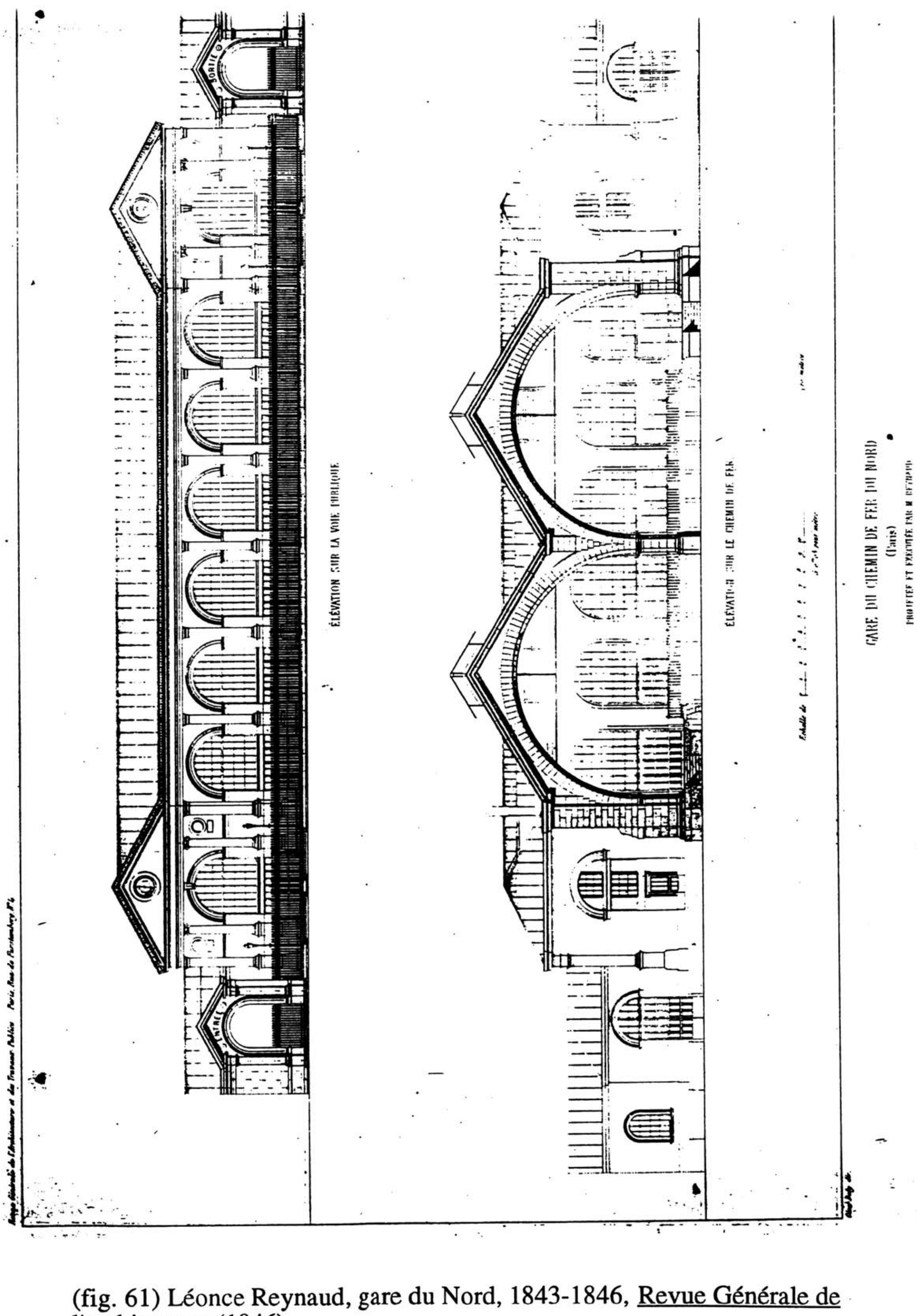
- Ci-dessus : Perspective d'un Phalanstère ou Palais Sociétaire dédié à l'humanité. D'après Victor Considérant, 1832.
- Ci-dessous : Le Château de Versailles en 1664, d'après Patel. Louis Le Vau, arch.

(fig. 58) Victor Considérant, phalanstery, 1832

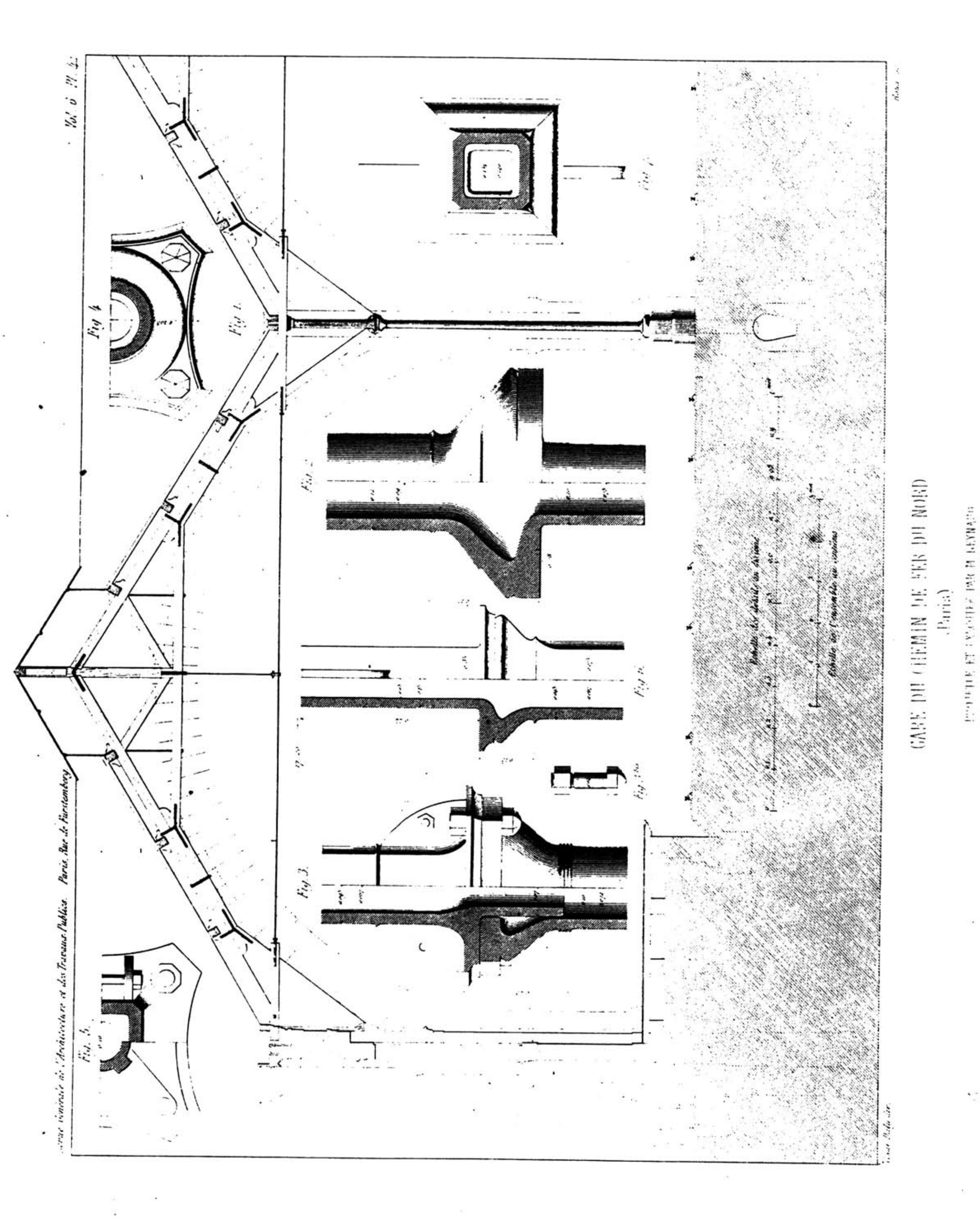




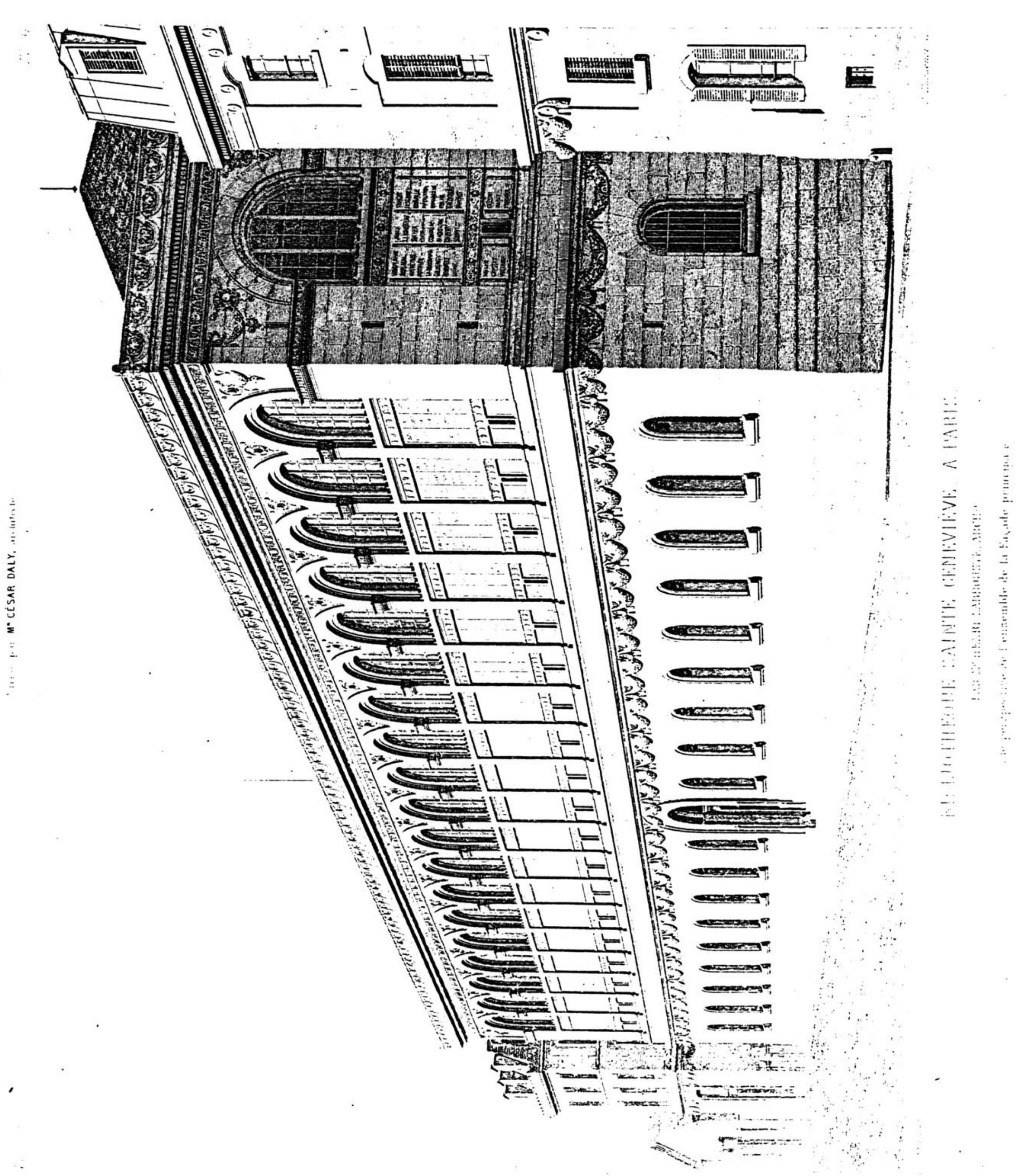
(fig. 59) Louis Duc, palace de Justice, 1857-68
(fig. 60) Léon Vaudoyer, Marseilles cathedral, 1856-93



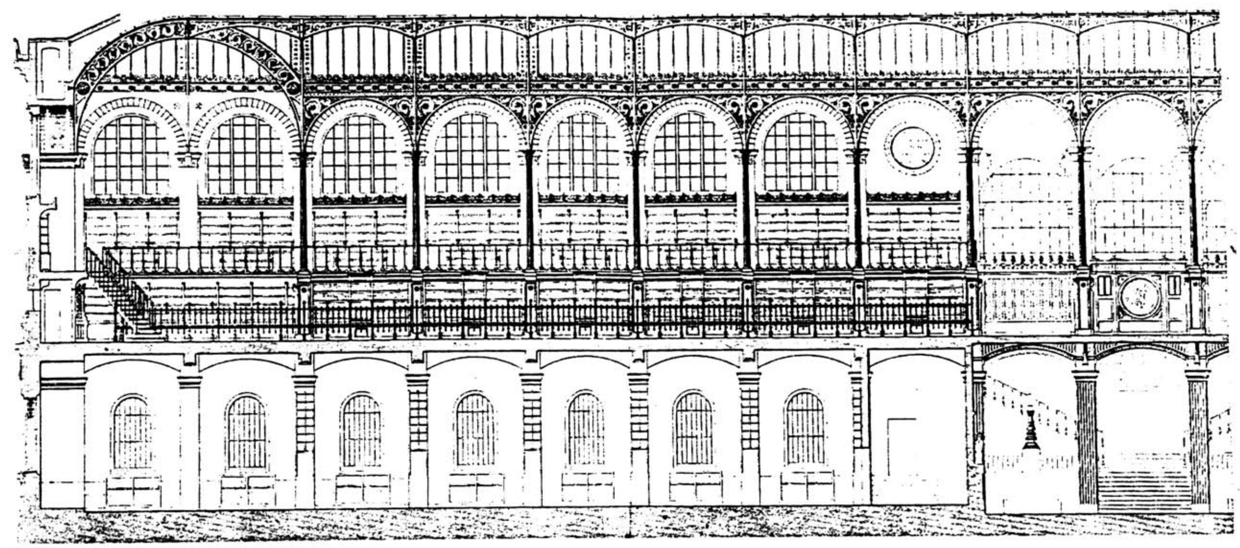
(fig. 61) Léonce Reynaud, gare du Nord, 1843-1846, <u>Revue Générale de l'architecture</u> (1846)

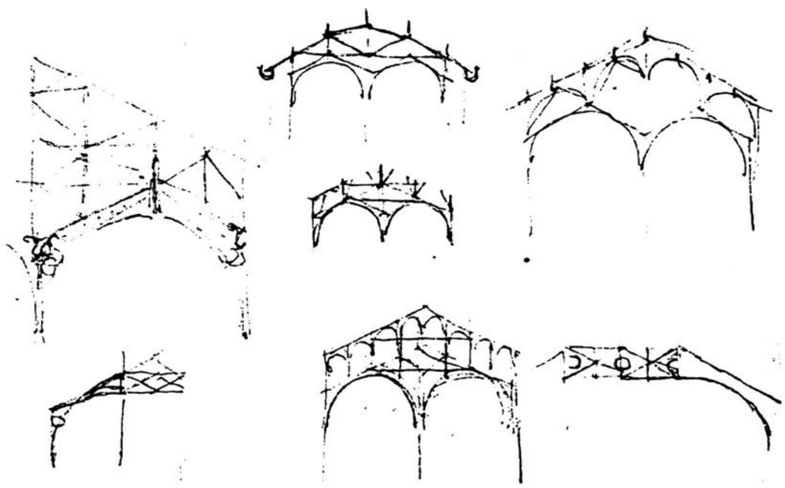


(fig. 62) Léonce Reynaud, gare du Nord, 1843-1846, <u>Revue Générale de l'architecture</u> (1846)

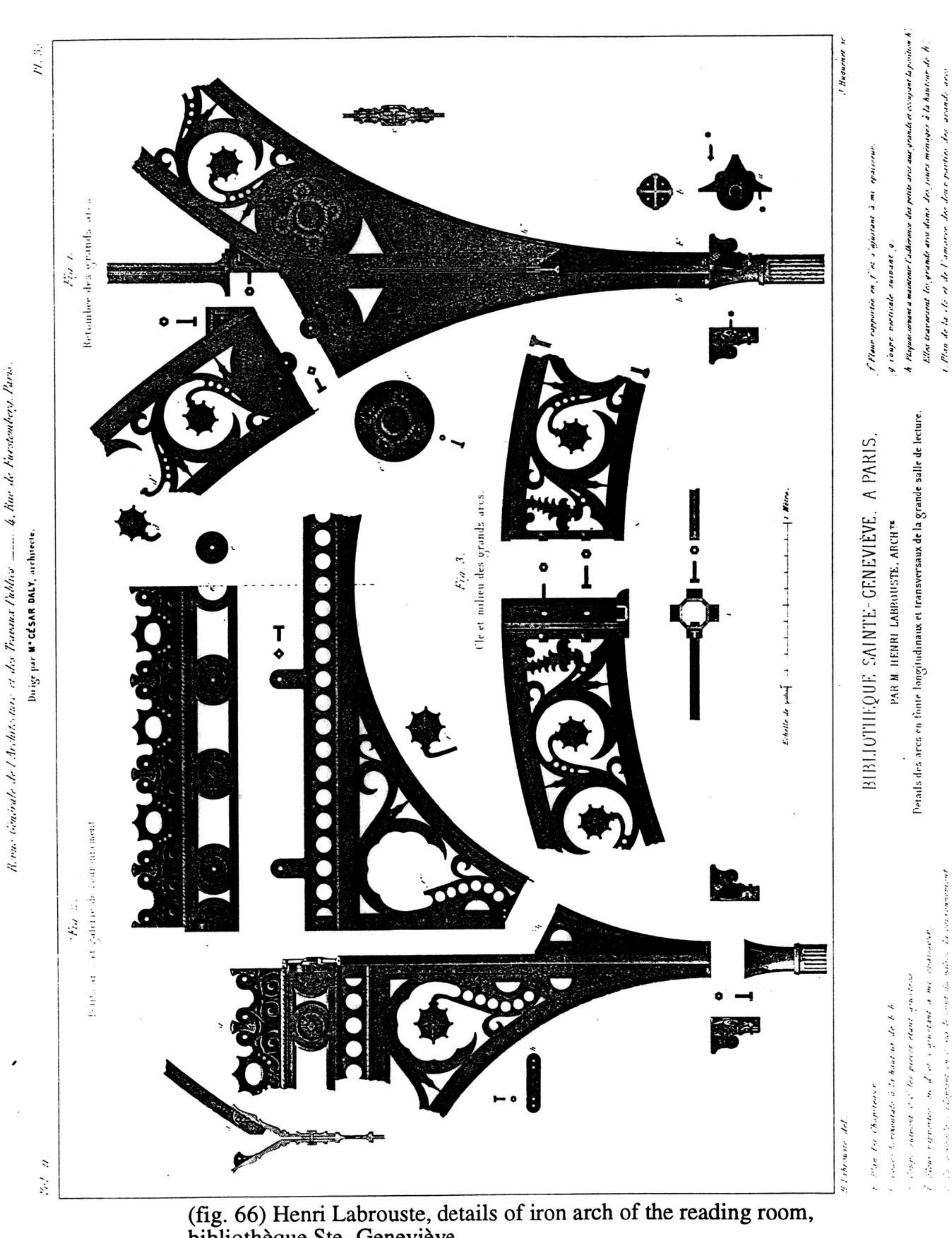


(fig. 63) Henri Labrouste, bibliothèque Ste.-Geneviève, 1842-50

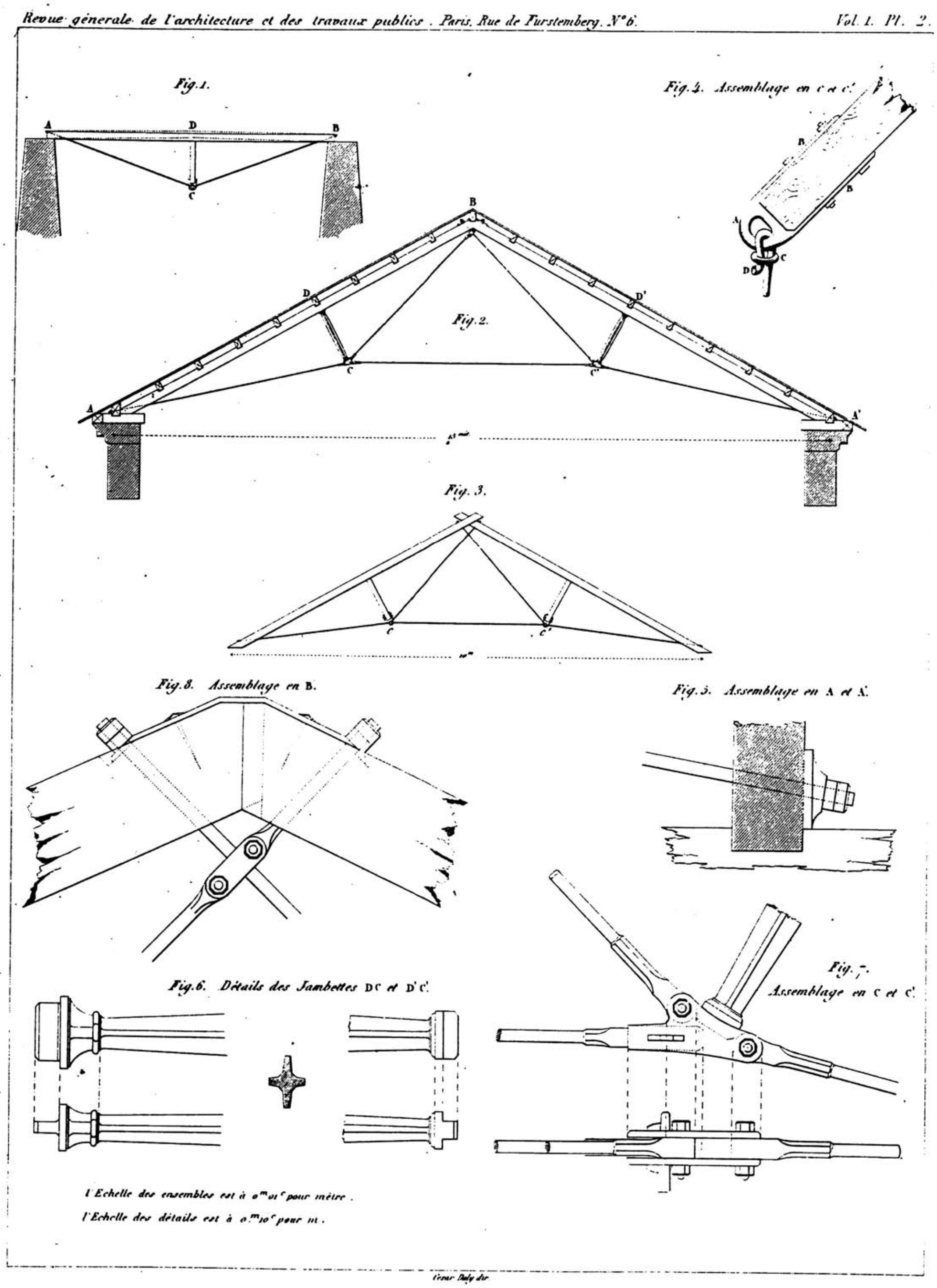




(fig. 64) Henri Labrouste, bibliothèque Ste.-Geneviève, longitudinal section
(fig. 65) Henri Labrouste, first sketches of roof structure



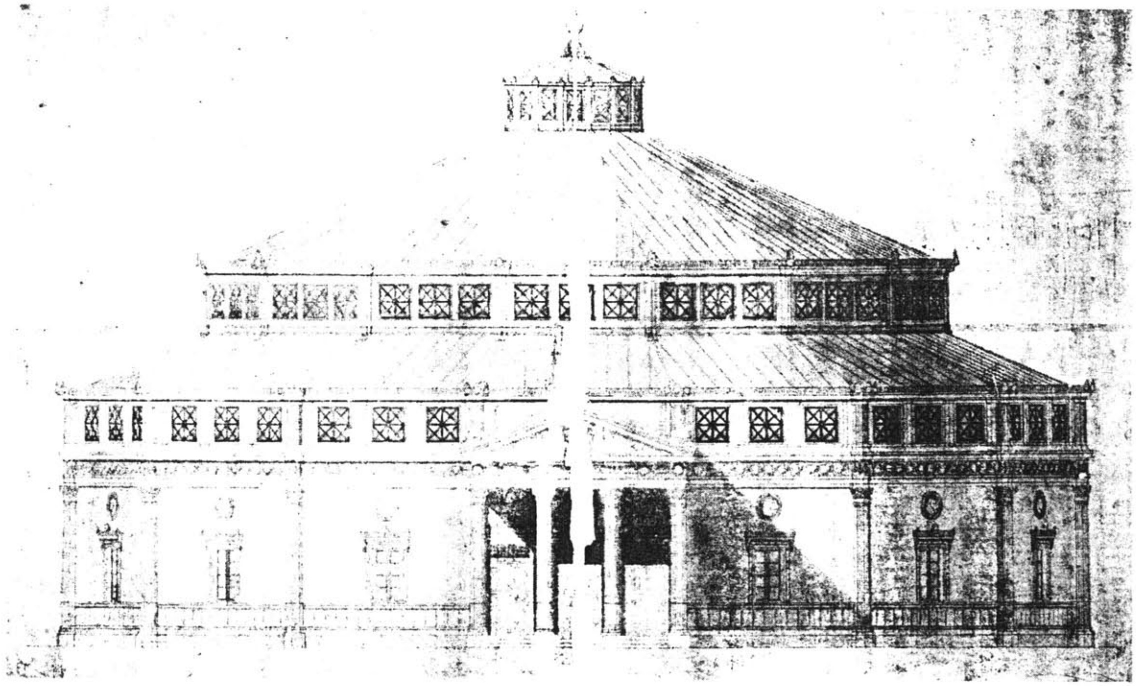
(fig. 66) Henri Labrouste, details of iron arch of the reading room, bibliothèque Ste.-Geneviève



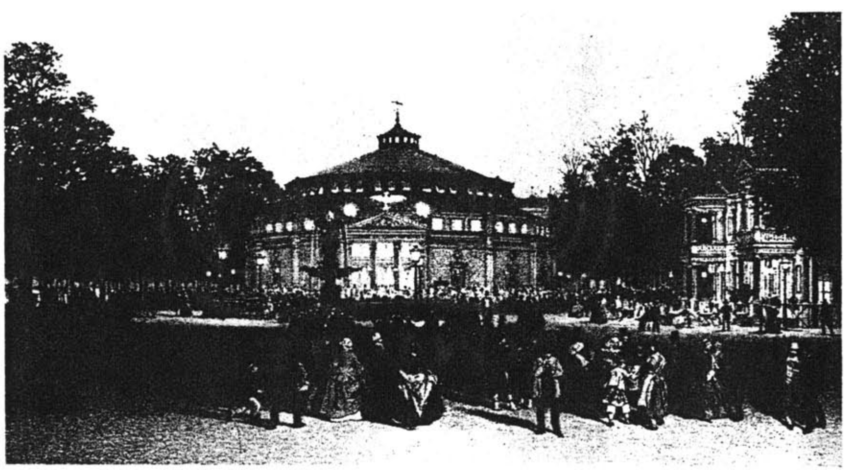
CHARPENTE EN BOIS ET EN FER.

(fig. 67) Polonceau truss, <u>Revue générale de l'architecture</u> (1840)

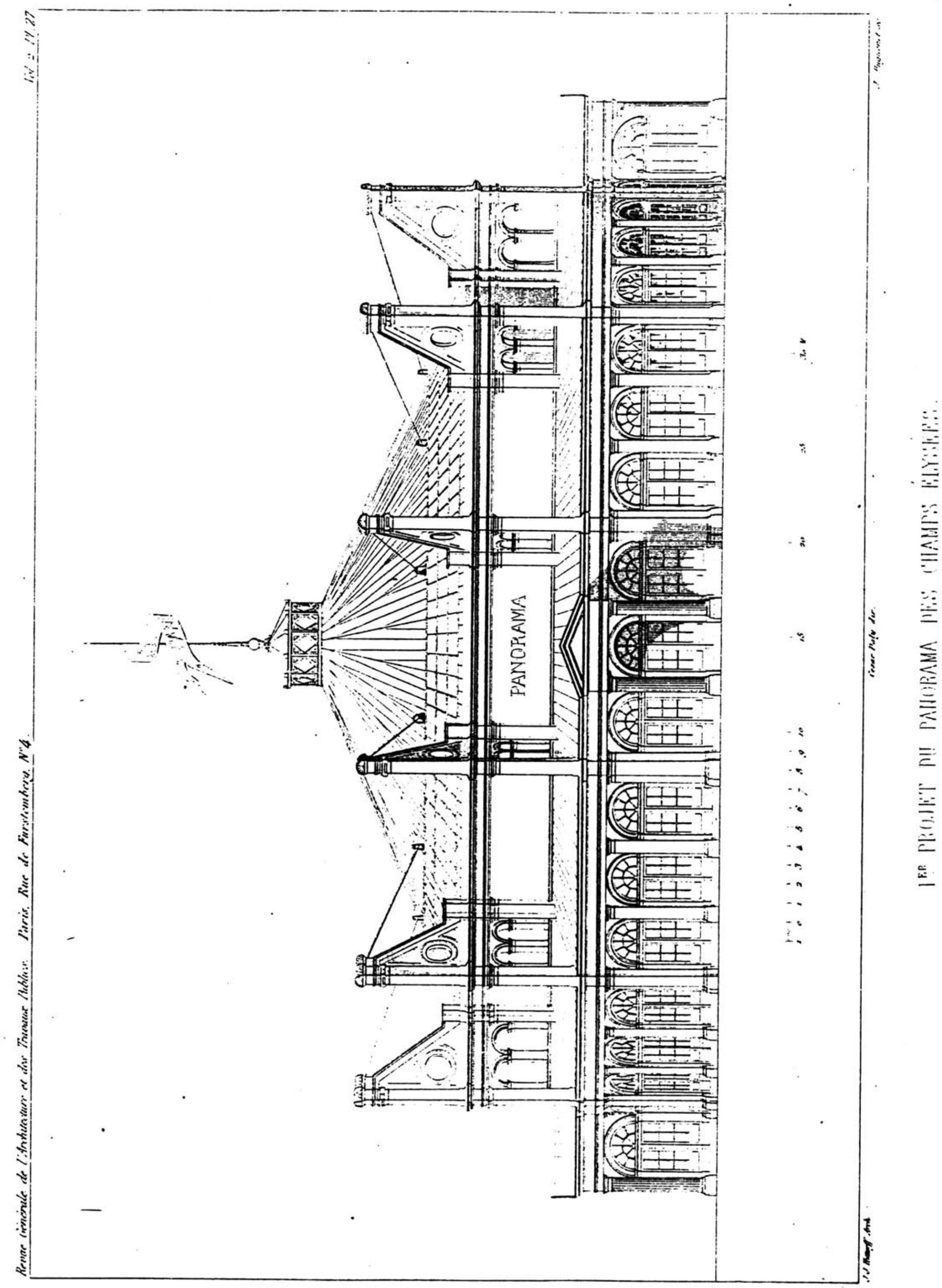
(fig. 68) Henri Labrouste, design of front cover, <u>Revue générale de l'architecture</u>



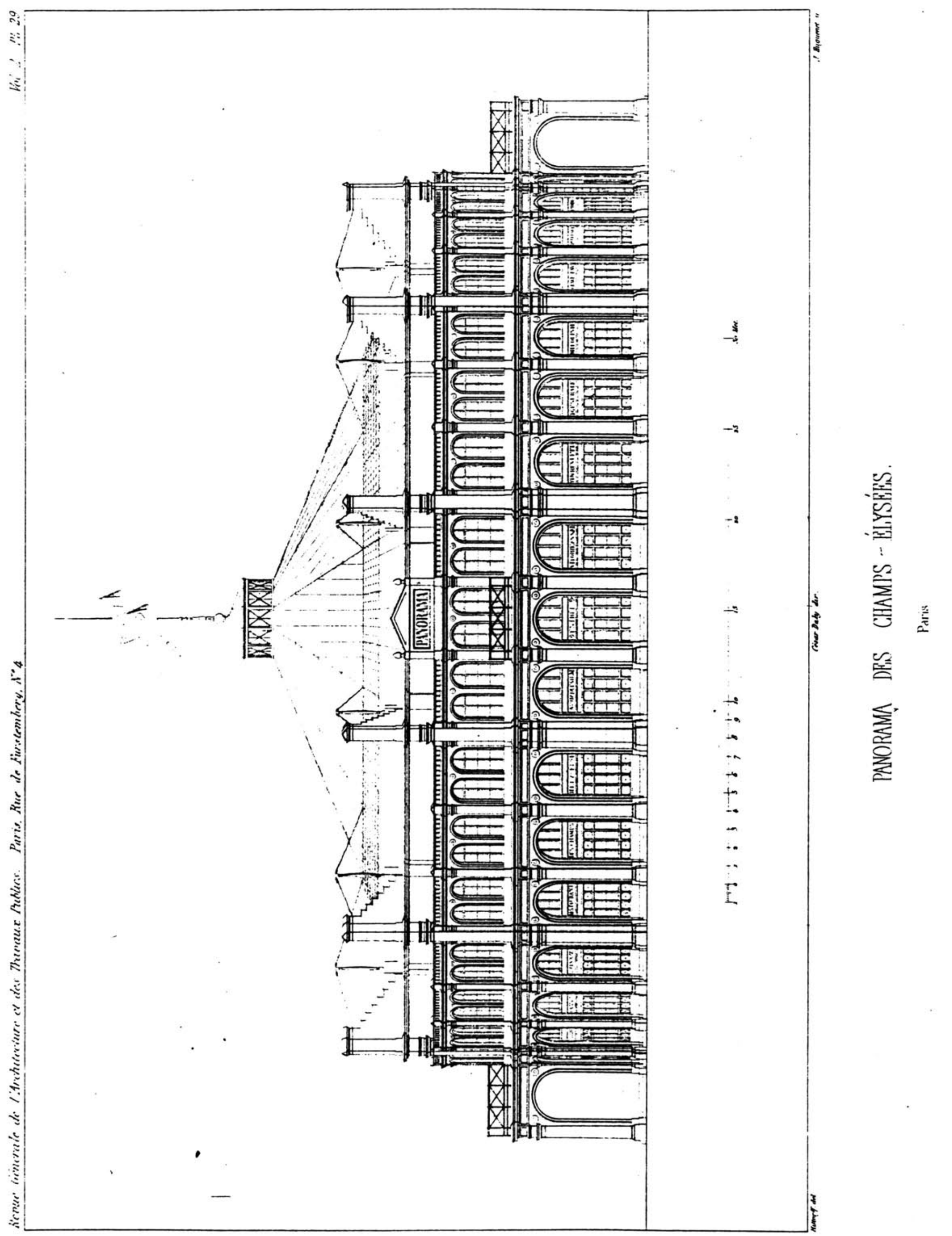
Ill. Cirque d'Été, Élévation de la façade principale, Cologne WRM. C.H. 27.



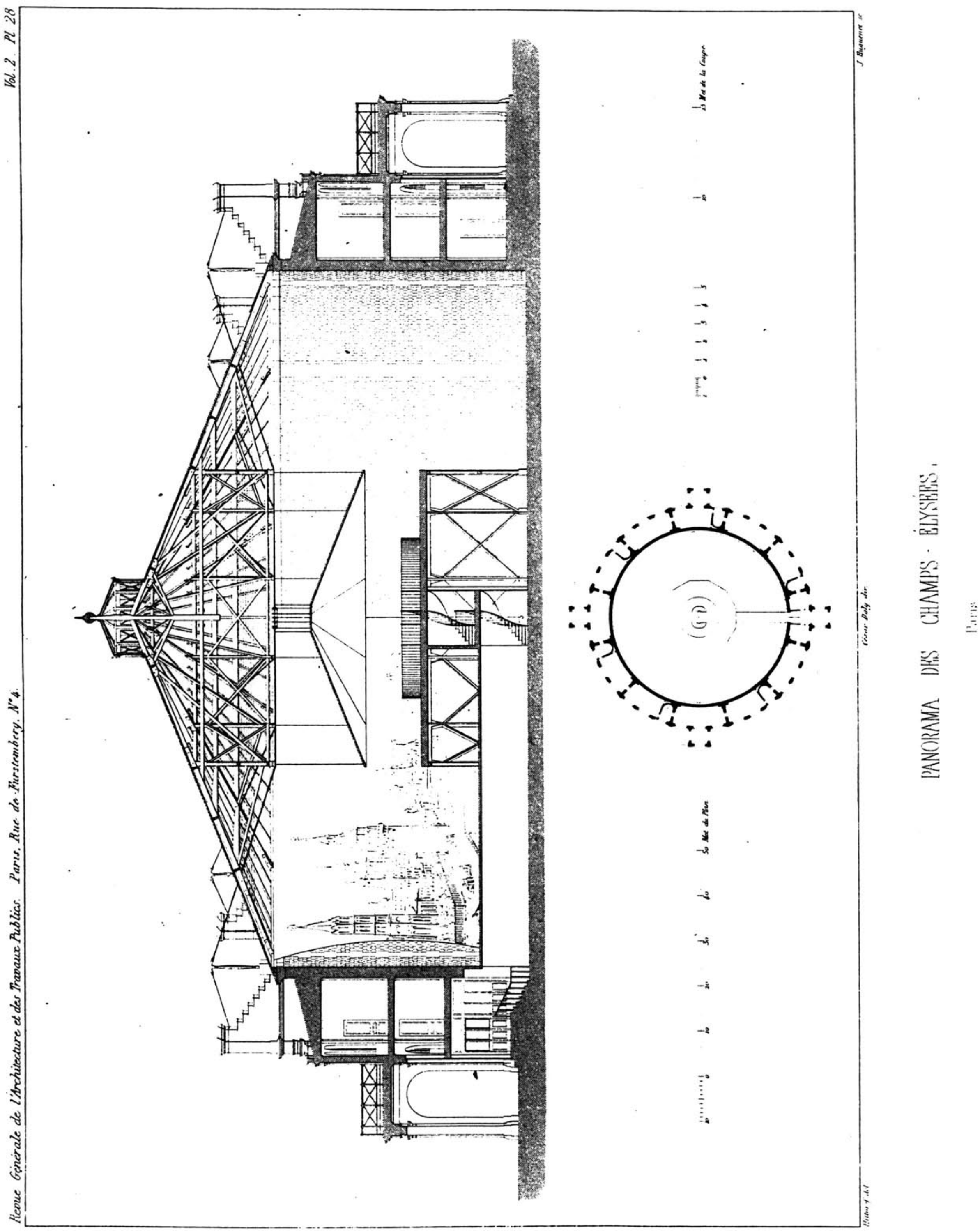
(fig. 69) J. Hittorff, cirque d'été, 1839-41



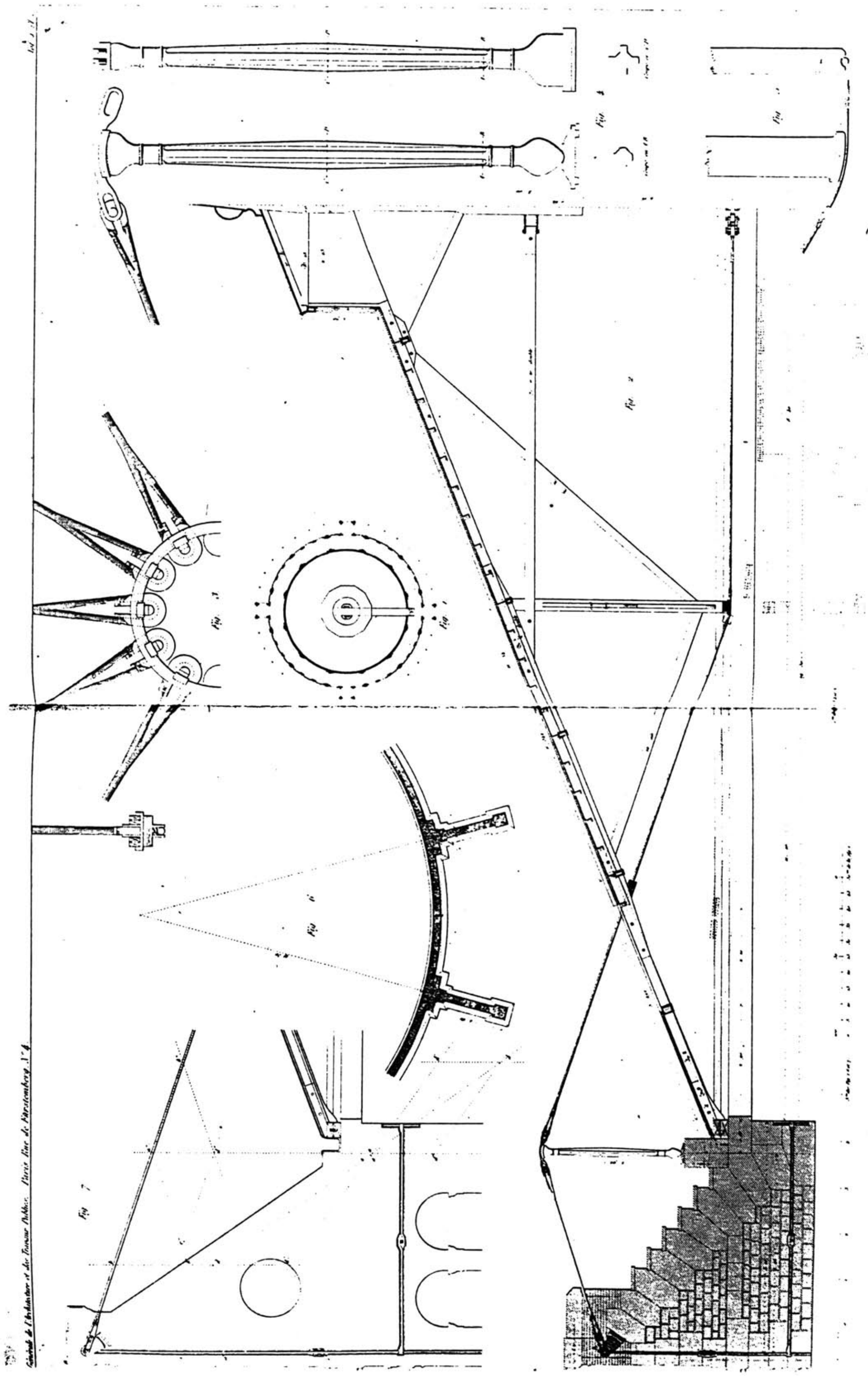
(fig. 70) J. Hittorff, first design of Panorama, 1839, from Revue générale de l'architecture (1841)



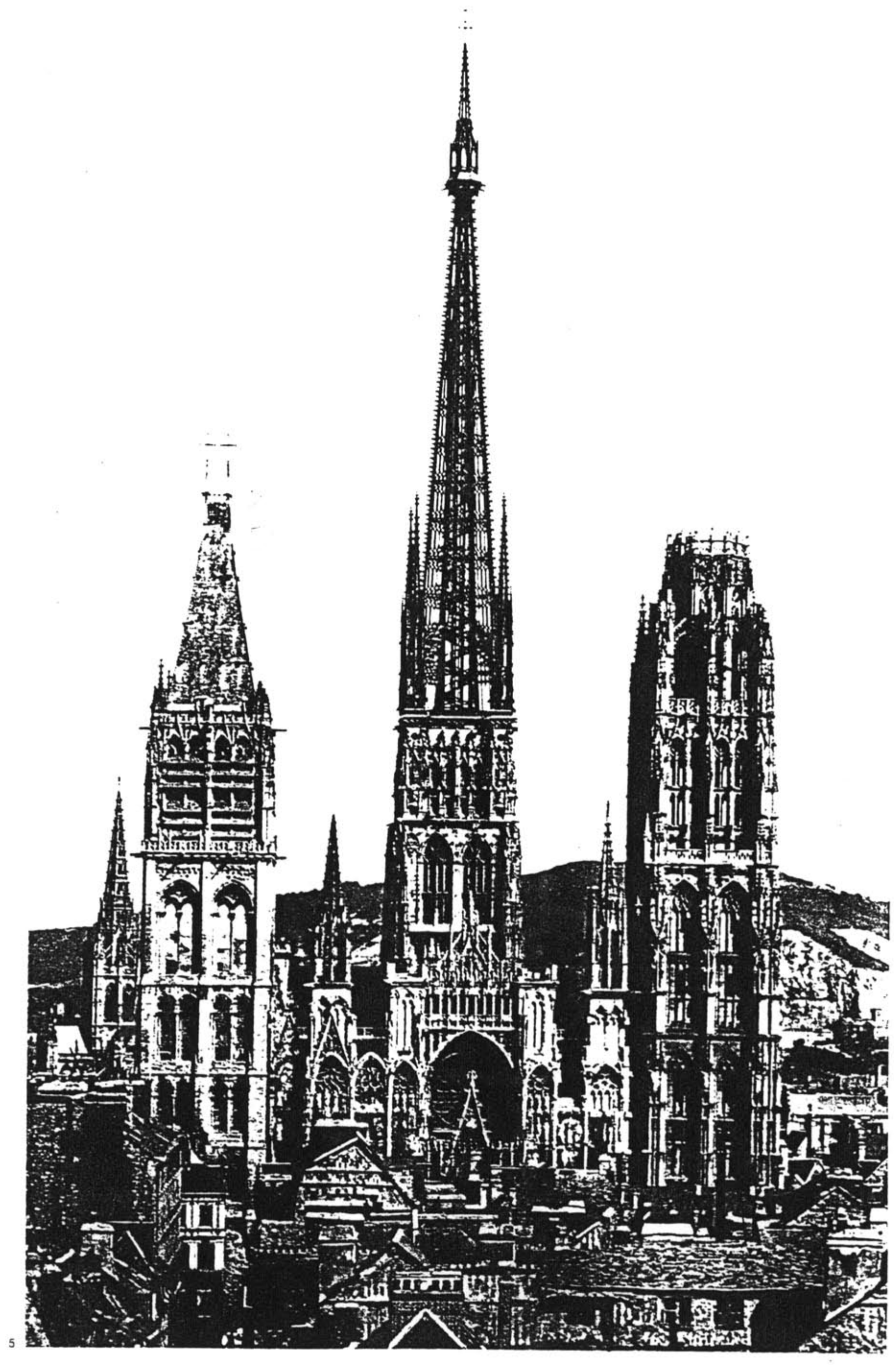
(fig. 71) J. Hittorff, final design of Panorama, 1839, from Revue générale de l'architecture (1841)



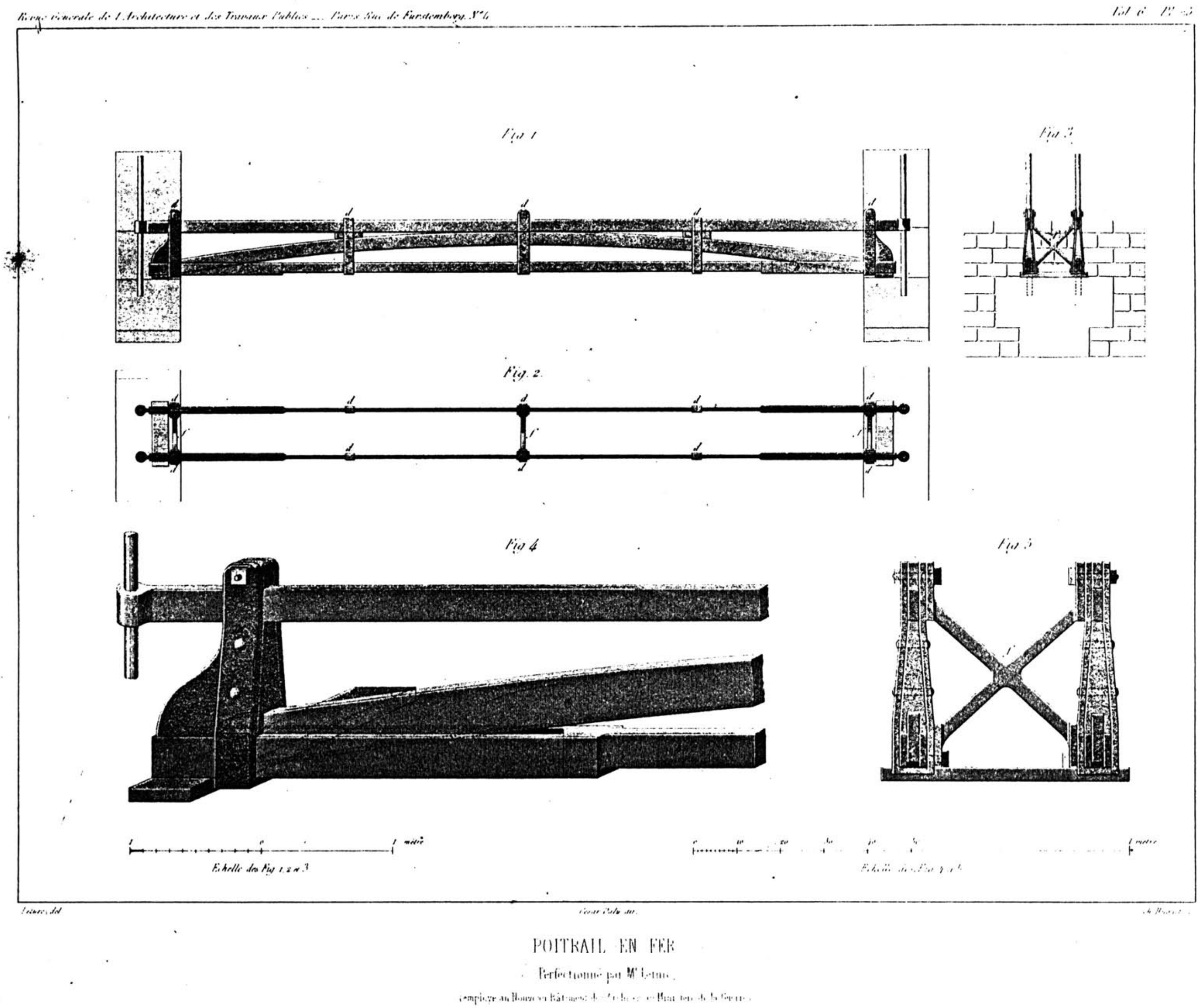
(fig. 72) Hittorff, section of the Panorama, 1839, from Revue Générale de l'architecture (1841)



(fig. 73) Hittorff, detail of the roof structure of the Panorama, from <u>Revue générale de l'architecture</u> (1841)

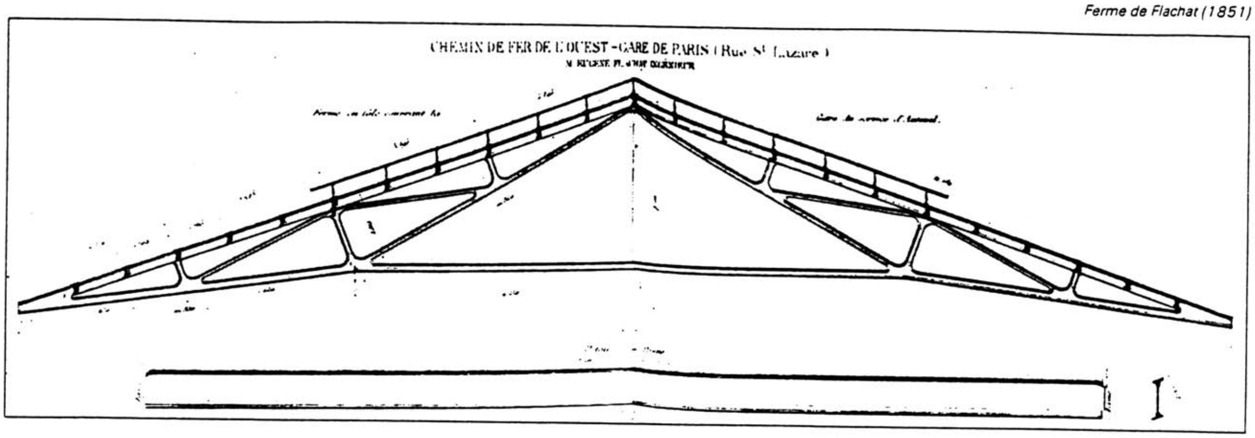


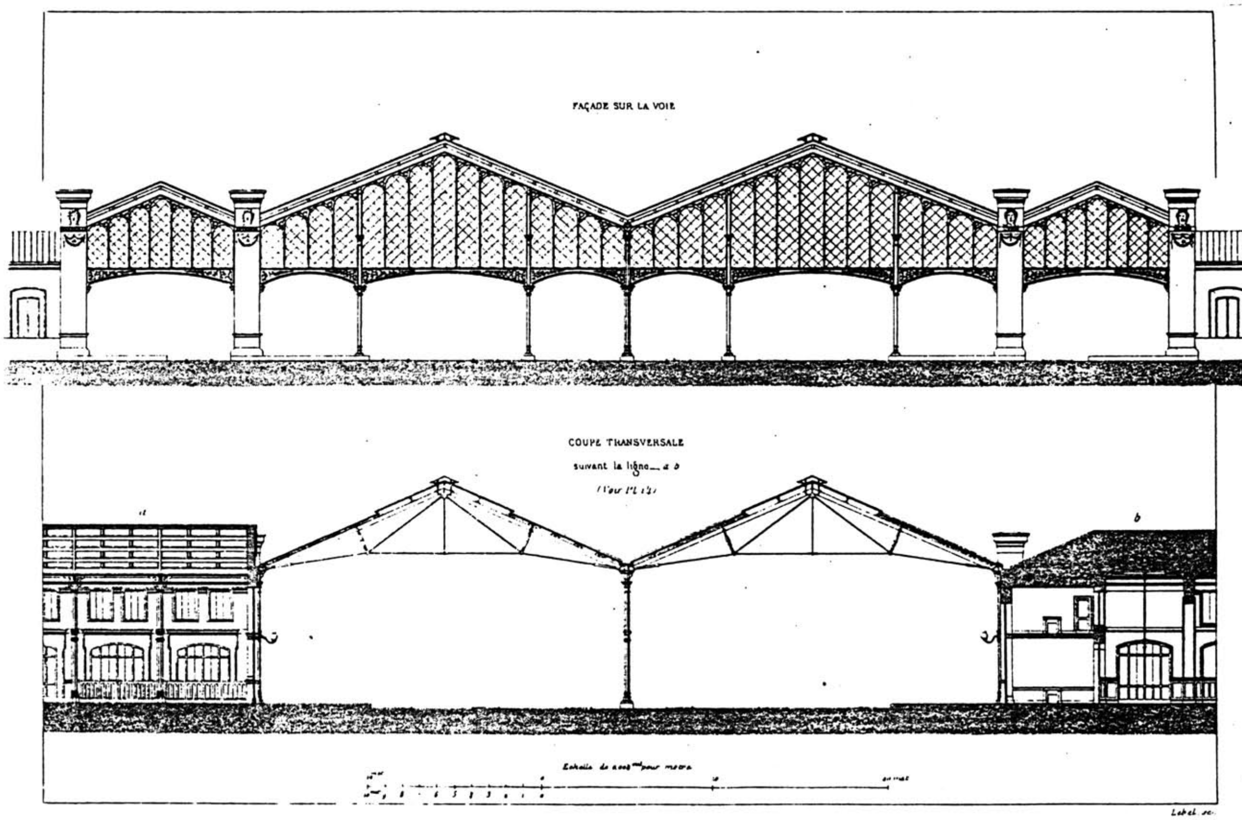
(fig. 74) Alavoine, cast iron flêche of the cathedral at Rouen, 1828-36



(fig. 75) Leturc, poitrail en fer, from Revue générale de l'architecture (1846)

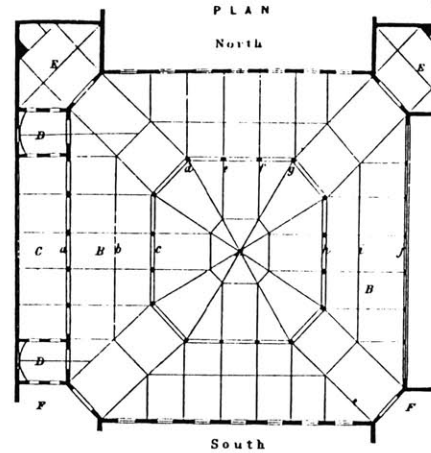
Ferme de Flachat (1851)





(fig. 76) Eugène Flachat, roof truss of St..-Lazare railway station, 1851
(fig. 77) A. Cendrier, gare de Lyon, Revue générale de l'architecture (1859)

18 b



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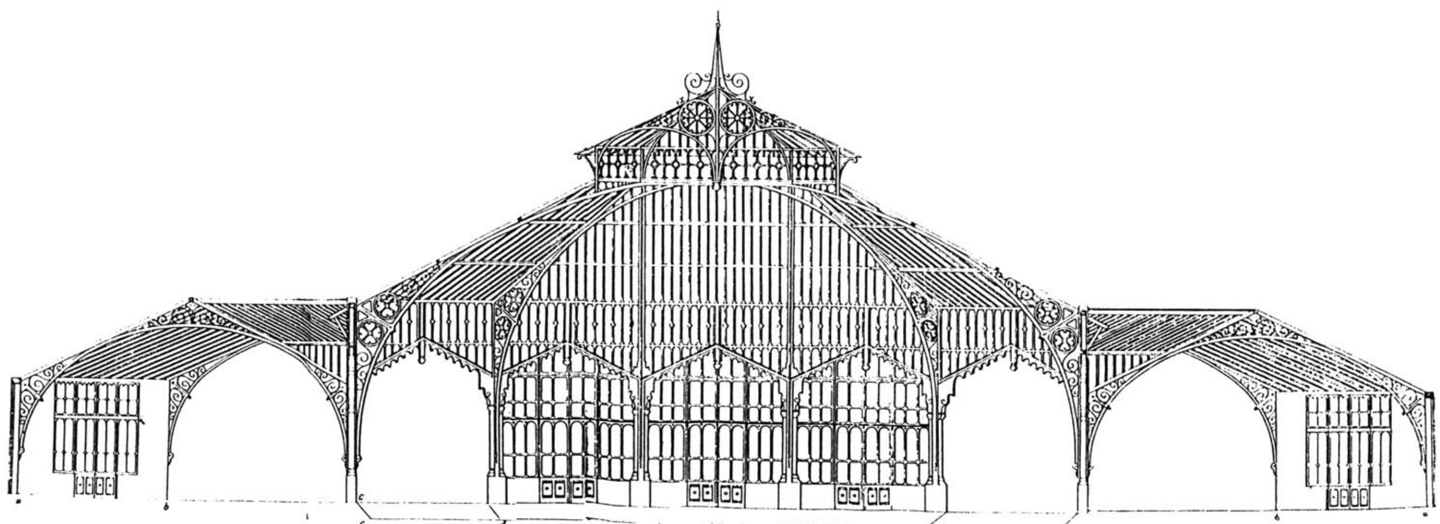
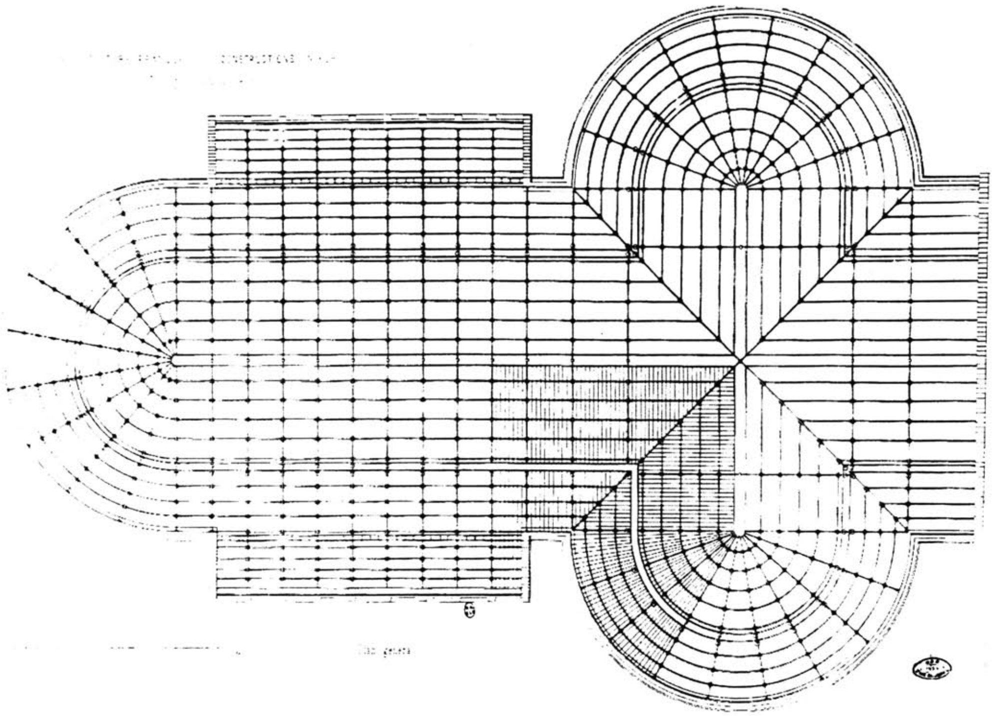
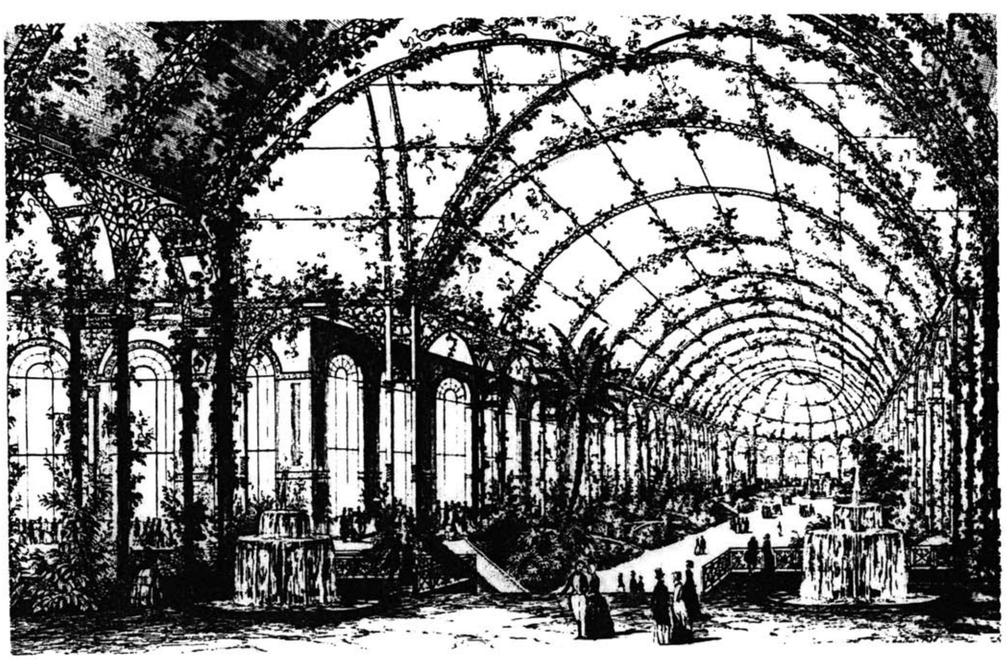


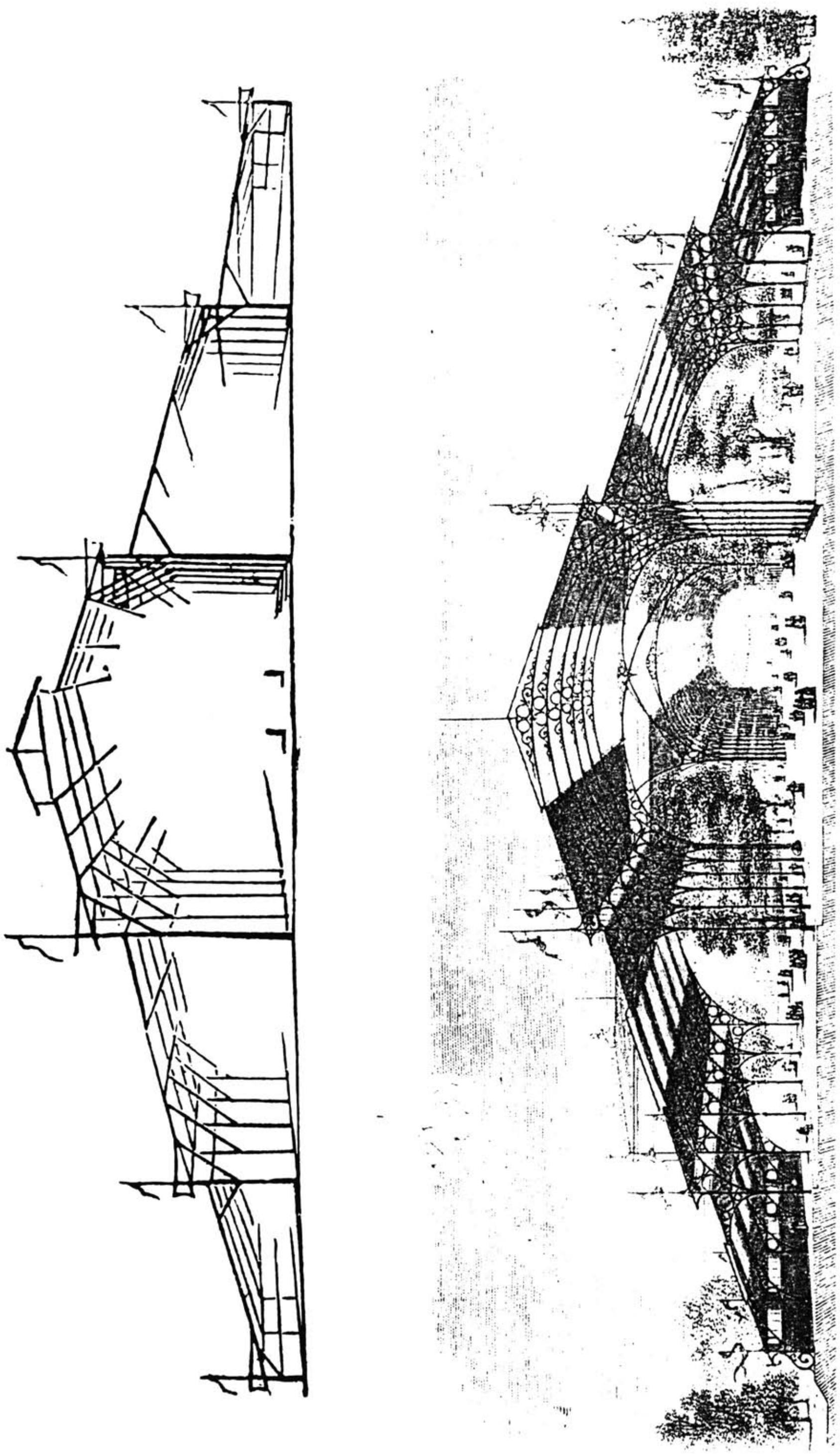
(fig. 78) Horeau, jardin d'hiver, Lyon, 1847



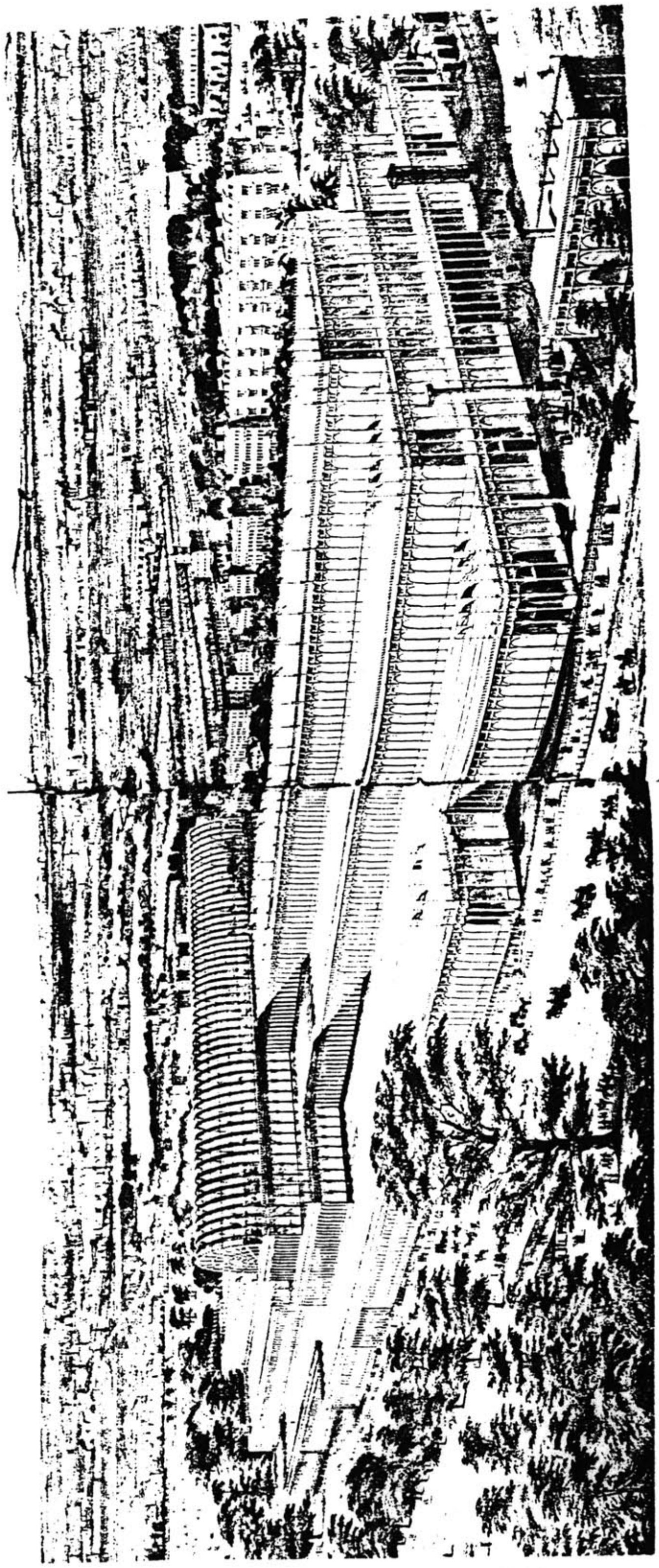
Page 130, en haut : les serres chaudes du Jardin des Plantes, par Rohault de Fleury, 1834. Le dessin montre les serres dans leur état complet. En réalité, l'aile droite ne sera construite qu'en 1934 (L. Rousseau, *Promenade au Jardin des Plantes*, 1837, p. 433). Au centre, à gauche : élévation latérale d'un pavillon et coupe sur les serres courbes ; dessin de Rohault (A.N.). A droite : perspective intérieure d'un des pavillons des serres et coupes sur la galerie latérale (Neuman, *L'Art de gouverner les serres*, p. 184). En bas : projet d'achèvement des serres chaudes du Muséum, par Rohault de Fleury, 1855 (A.N.). Page 131 : plan et coupe du jardin d'hiver des Champs-Elysées, par Meynadier de Flamalens, 1846, montrant ses véritables proportions et sa structure métallique réalisée par Rigolet (*Moniteur des architectes*, 1860, pl. 693-696).



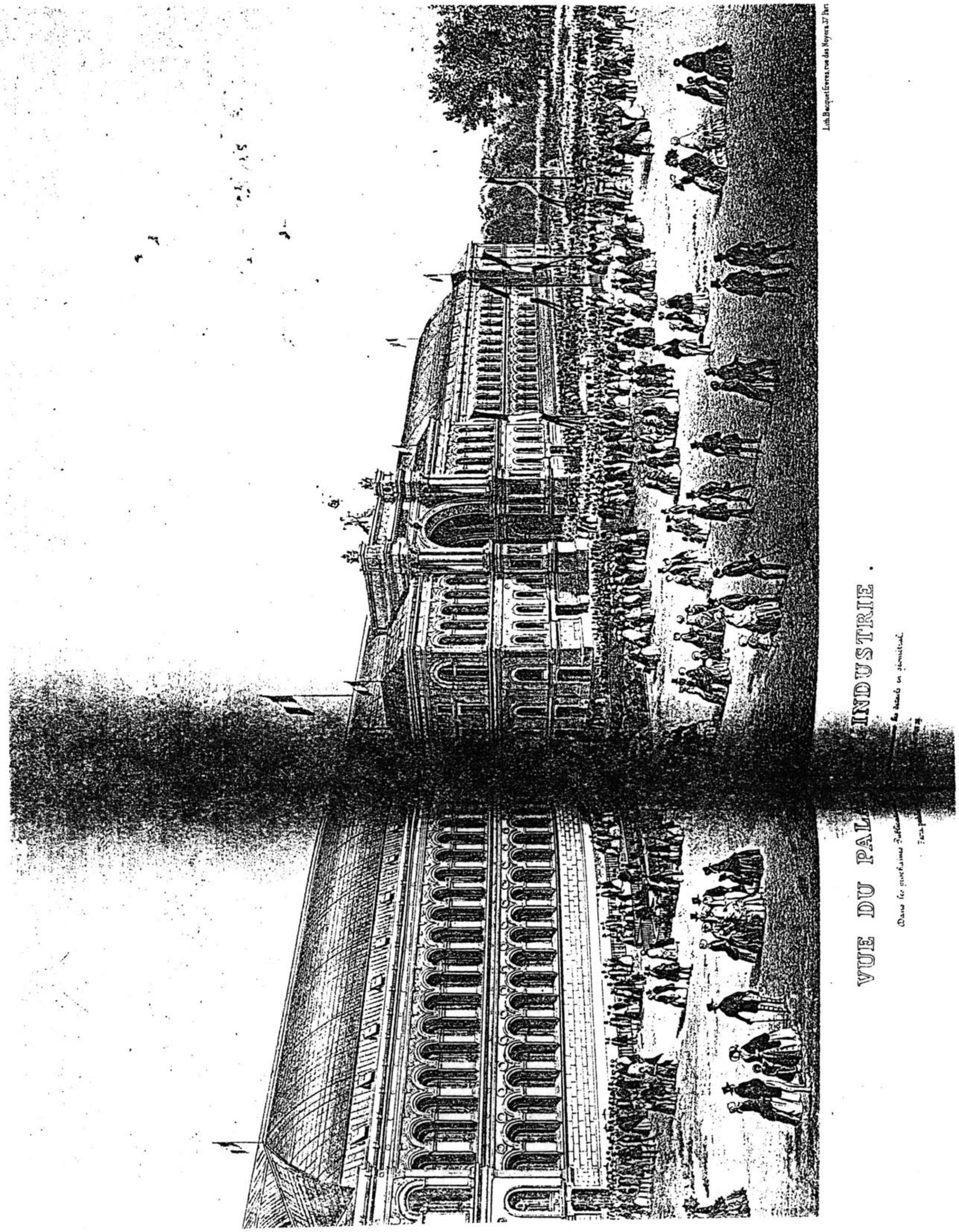
(fig. 79) Meynadier and Rigolet, jardin d'hiver, Champs Elysées , 1848



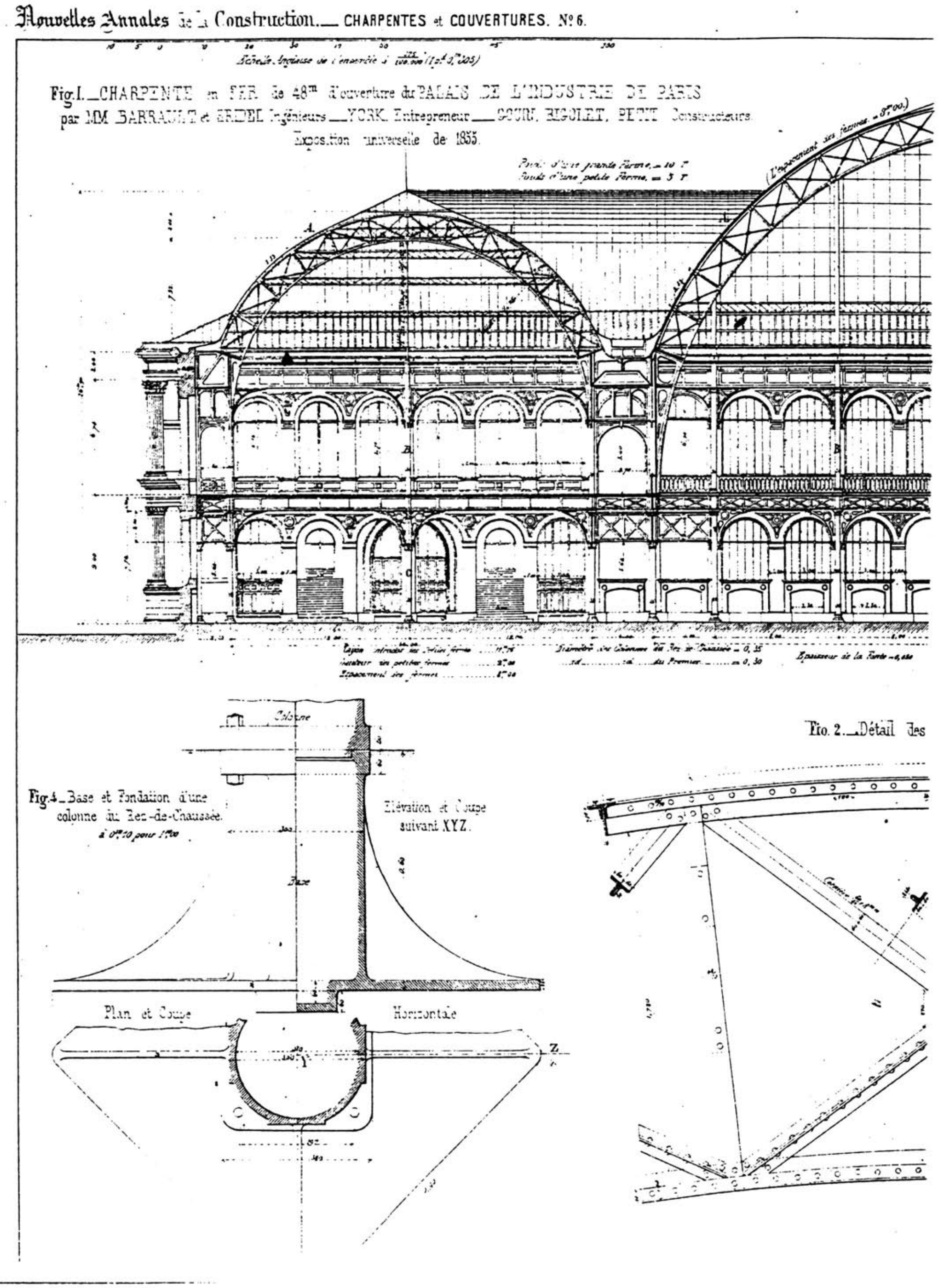
(fig. 80) Hector Horeau, proposal for exhibition hall, wood (1847), iron (1849)



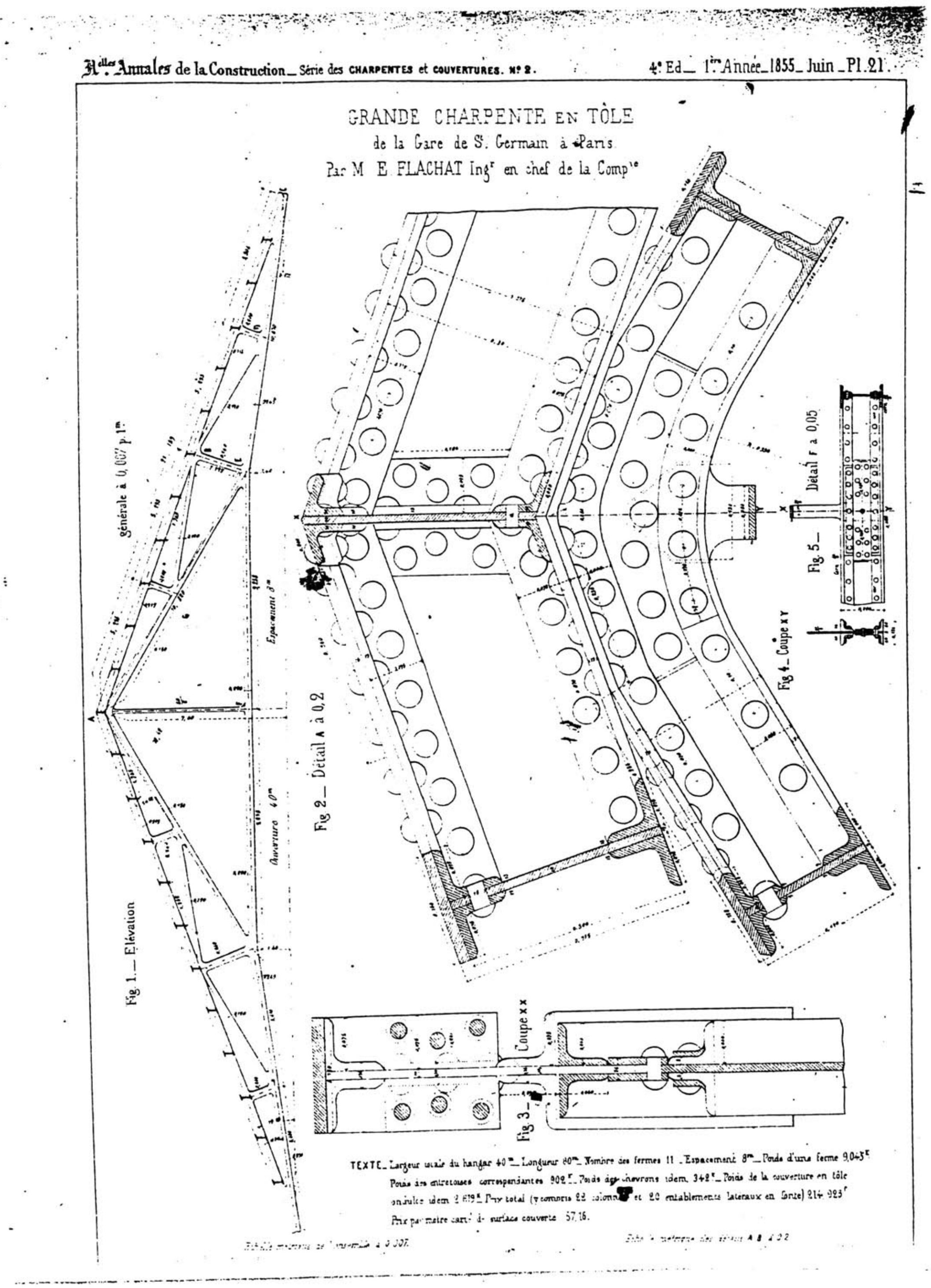
(fig. 81) J. Paxton, Crystal Palace, 1851



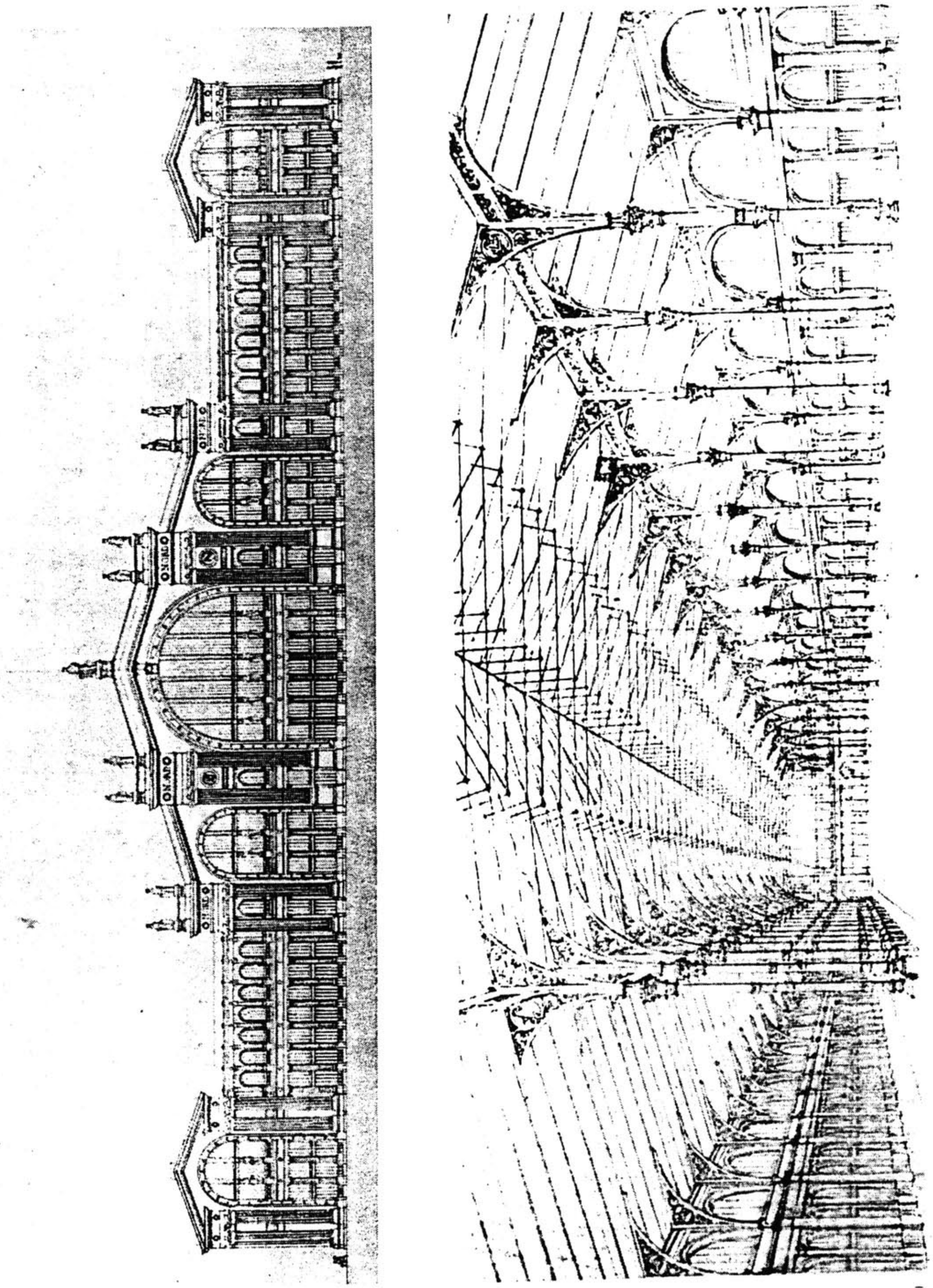
(fig. 82) Barrault and Bridel, facade of the Palais de l'industrie, 1855



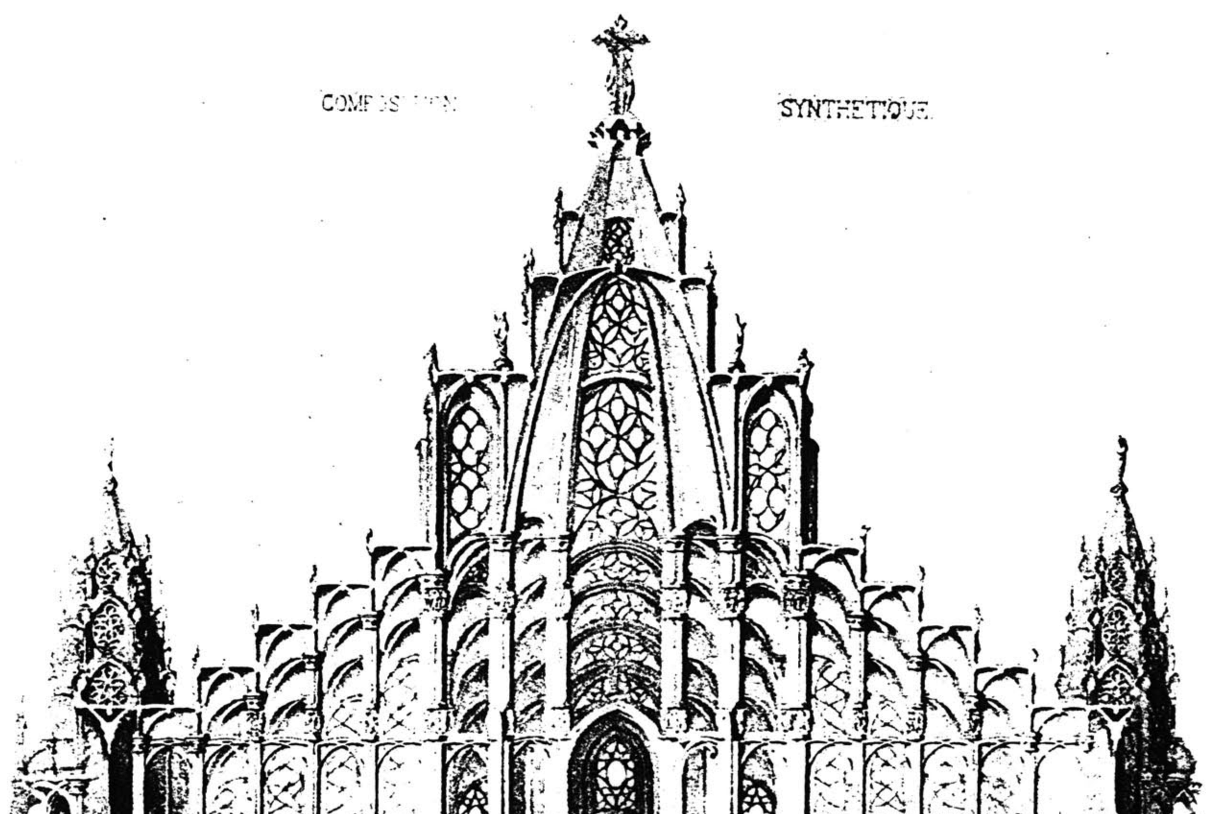
(fig. 83) Iron structure of the interior of the Palais de l'industrie, 1855 , from Nouvelles Annales de la Construction (1856)



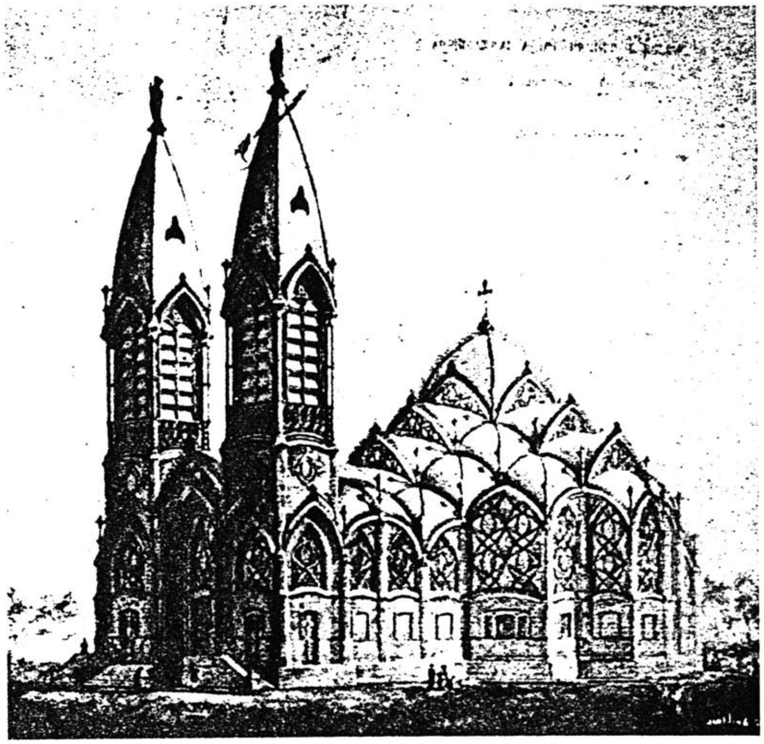
(fig. 84) Calculation of structural members of truss, from <u>Nouvelles Annales de la Construction</u> (1855)

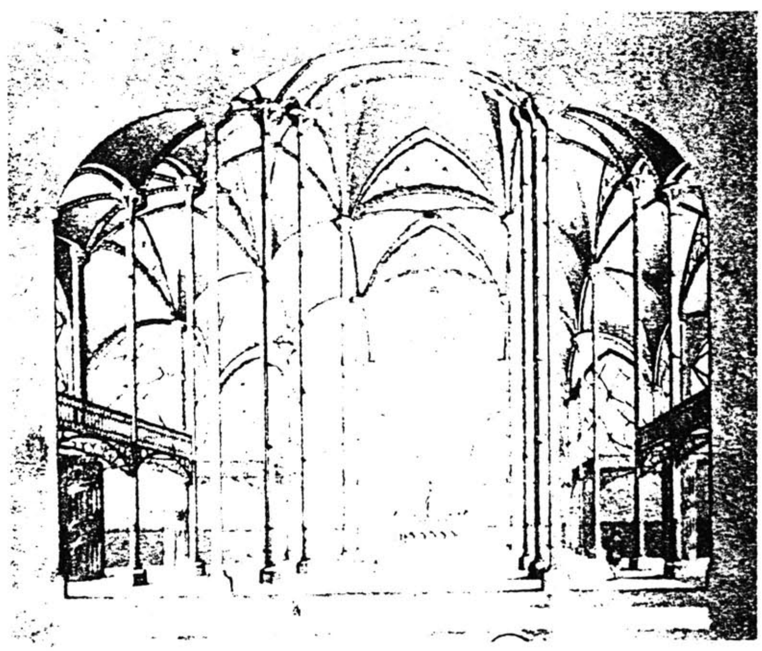


(fig. 85) J. Hittorff, gare du Nord, exterior and interior views



(fig. 86) Boileau, composition synthétique, 1850, perspective, Nouvelle forme architecturale (1853)
(fig. 87) Boileau, composition synthétique, 1850, section, Nouvelle forme architecturale (1853)





(fig. 88) Boileau, project for Saint-Denis church, Nouvelle forme architecturale (1853)
(fig. 89) Boileau, project for Saint-Denis church, Nouvelle Forme Architecturale (1853)

(fig. 90) Boileau, project for iron church at the Chaussée-d'Antin, 1854,
L'Illustration (1854)

Projet d'église pour la paroisse de Saint-André, dans la Chaussée-d'Antin, par M. Boileau, architecte.

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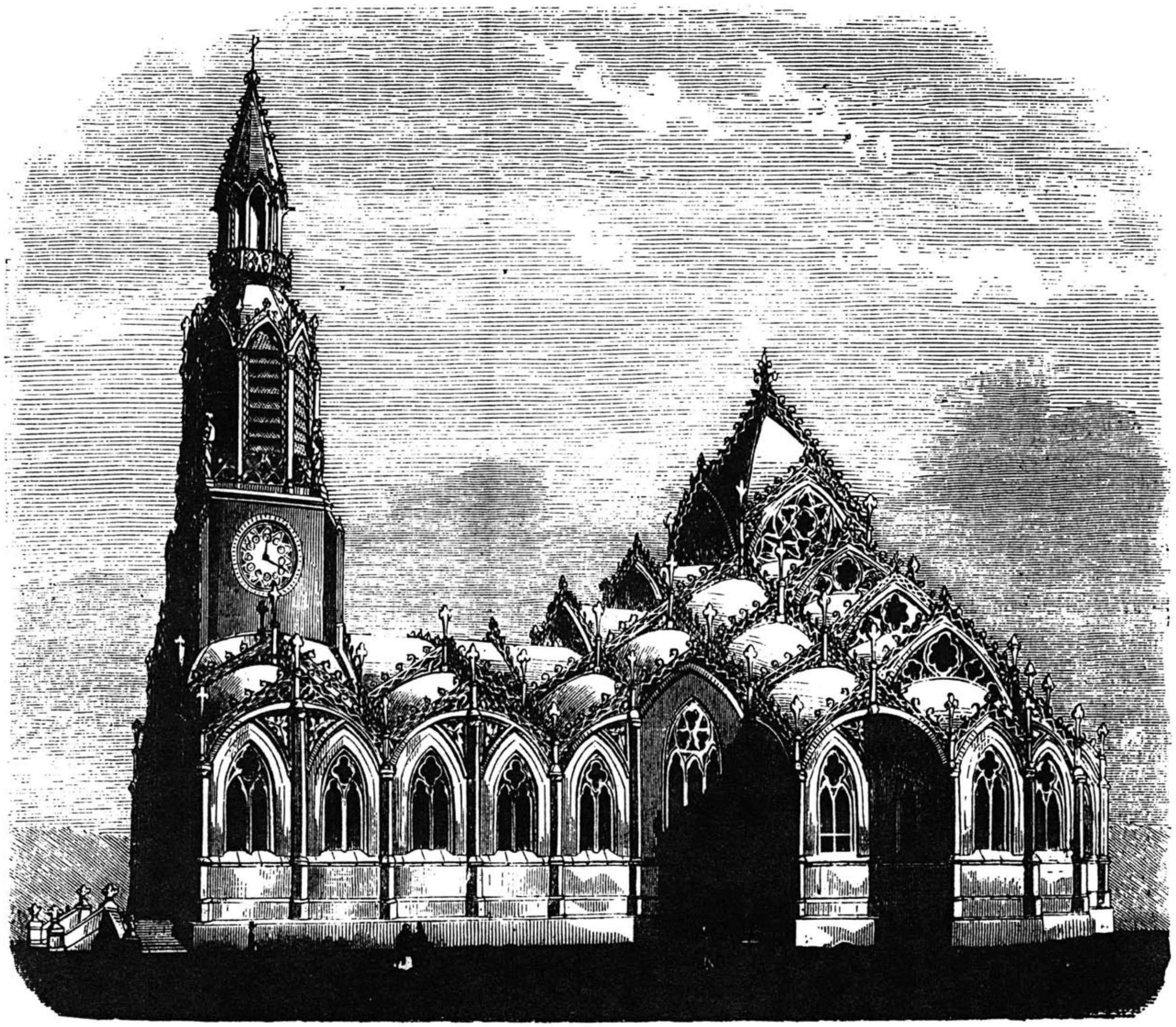

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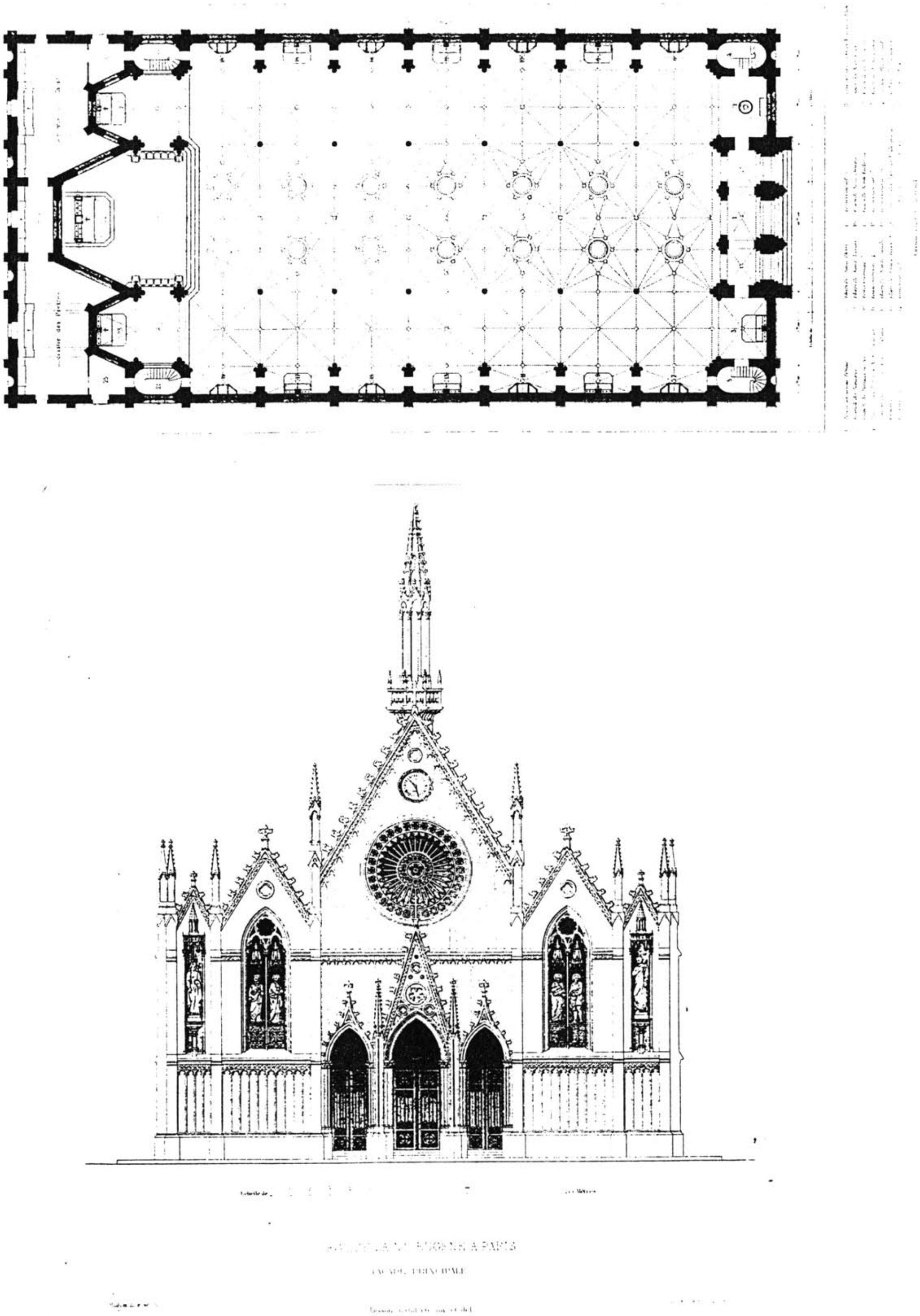
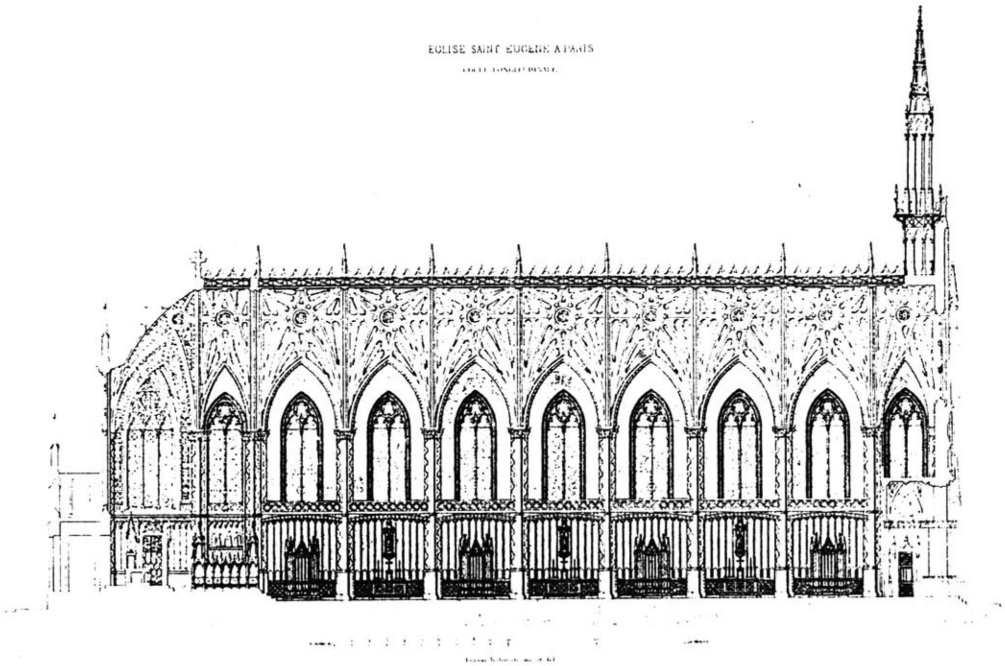
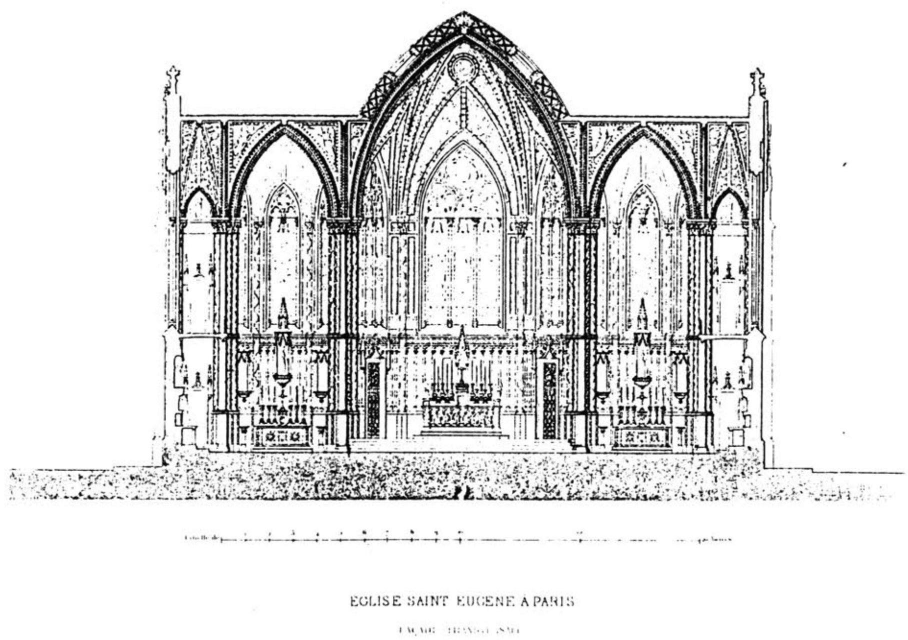
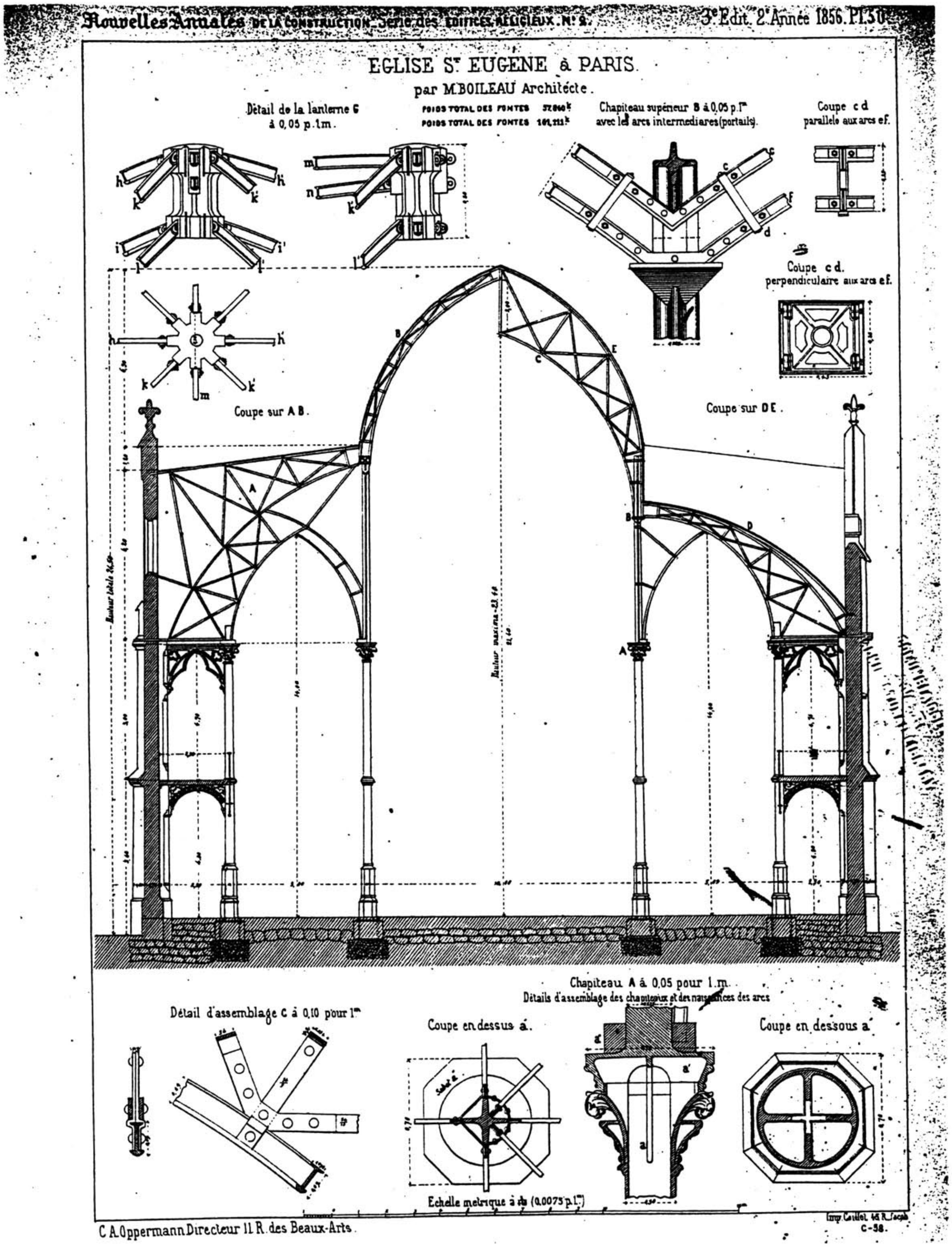


(fig. 91) Lusson, church of Ste.-Eugène, 1855, plan and elevation, from <u>Plans, Coupes, Élévations et Détails de l'Église de Sainte-Eugène</u>

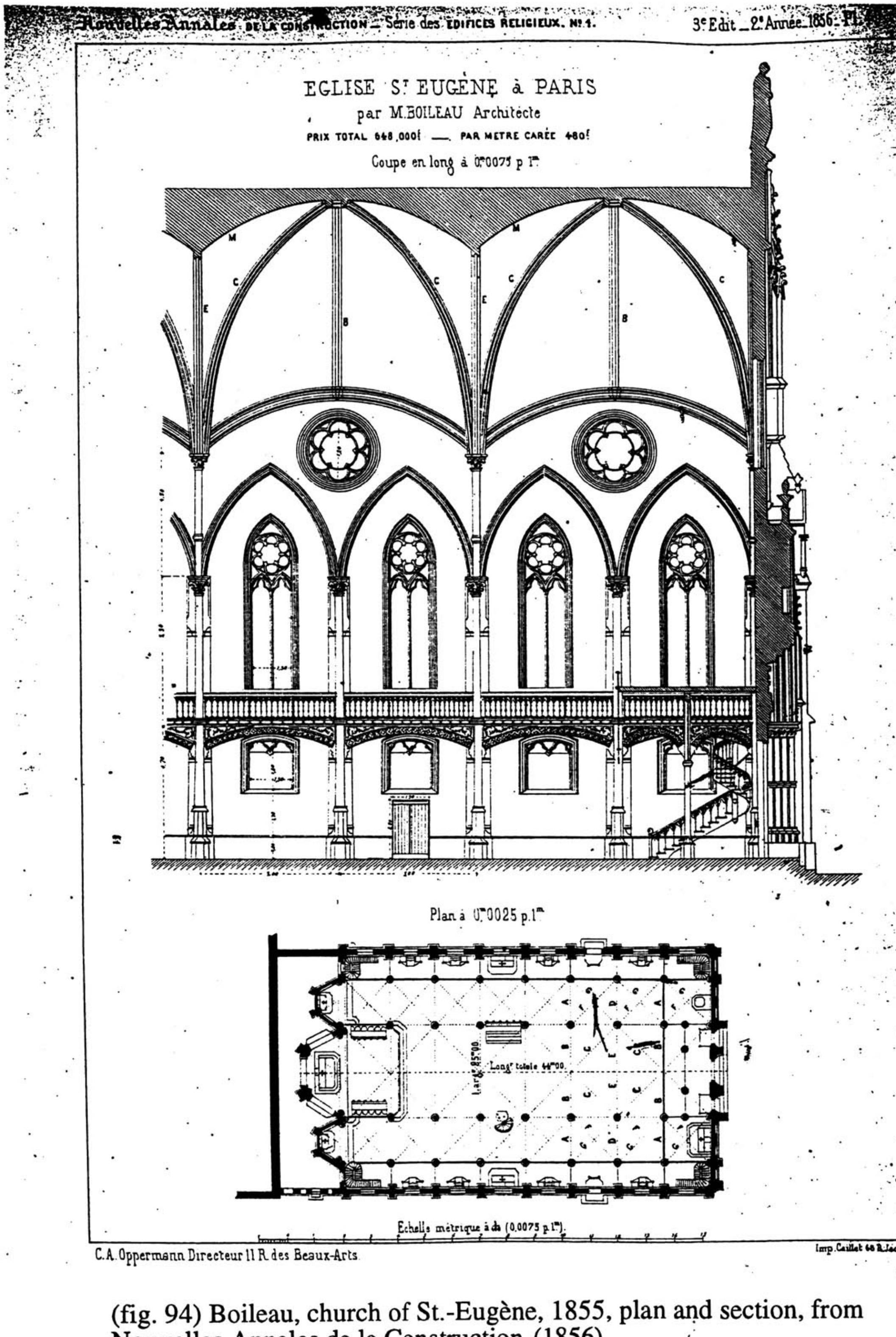




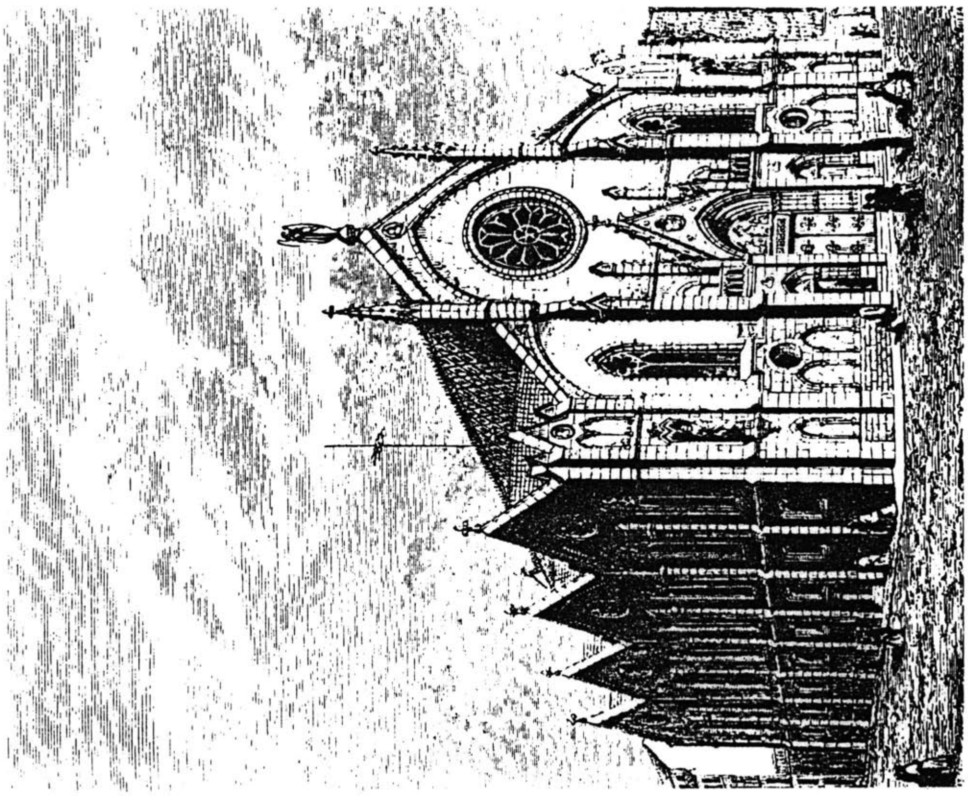
(fig. 92) Lusson, church of Ste.-Eugène, 1855, Sections, from <u>Plans, Coupes, Élévations et Détails de l'Église de Sainte-Eugène</u>

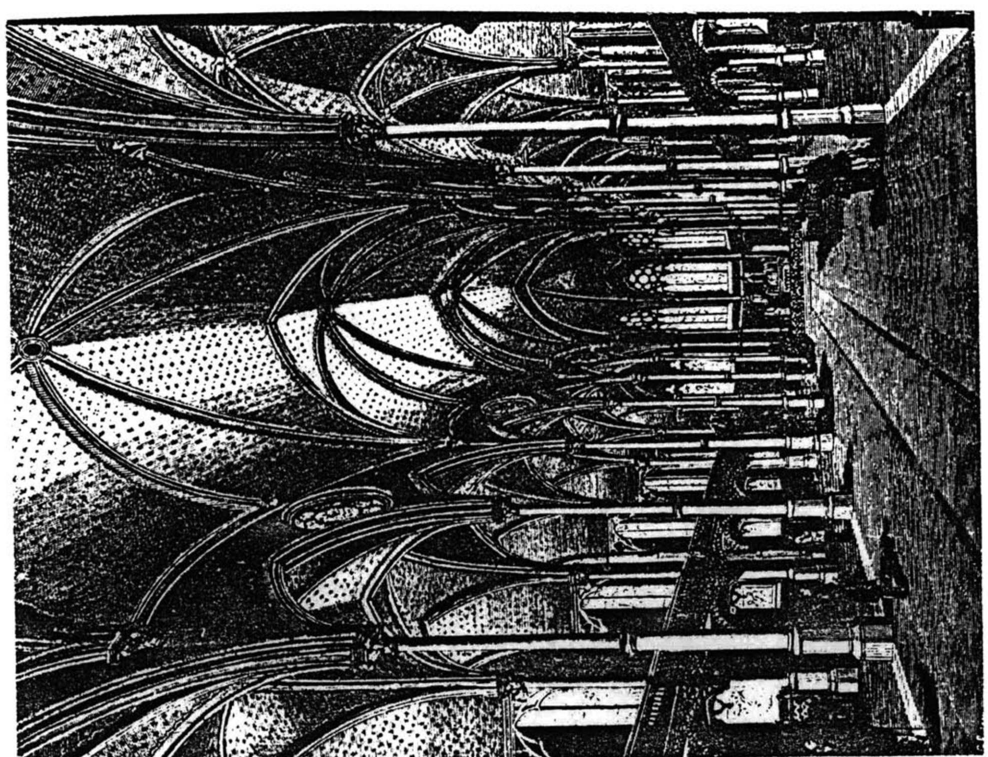


(fig. 93) Boileau, church of St.-Eugène, 1855, iron structure, from <u>Nouvelles Annales de la Construction</u> (1856)



(fig. 94) Boileau, church of St.-Eugène, 1855, plan and section, from Nouvelles Annales de la Construction (1856)





(fig. 95) Boileau, church of St.-Eugène, 1855, exterior view
(fig. 96) Boileau, church of St.-Eugène, 1855, interior view

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(fig. 97) Boileau, iron halls, 1865, Histoire critique de l'invention en architecture (1886)

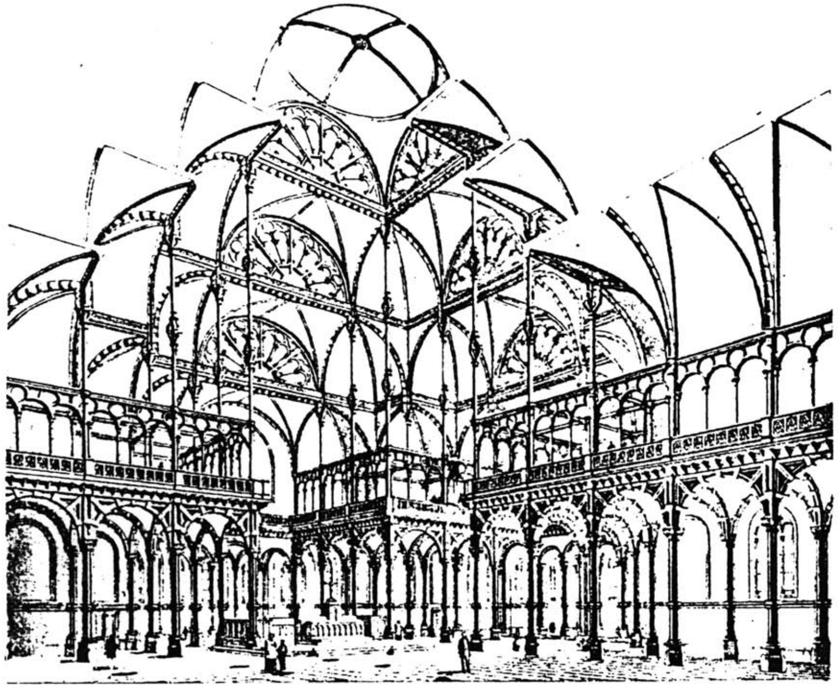


Fig. 10. Système des voussures imbriquées. Application à une église. Vue intérieure. Vers 1865. H.C.I., pl. III.

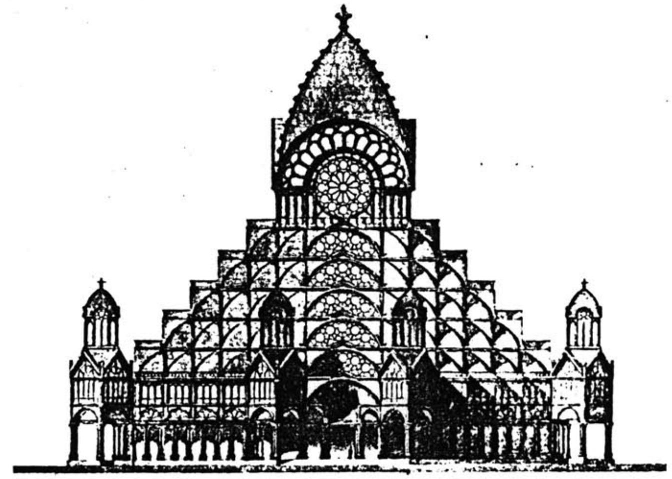


Fig. 14. Palais d'assemblée, coupe transversale. H.C.I., pl. VI.

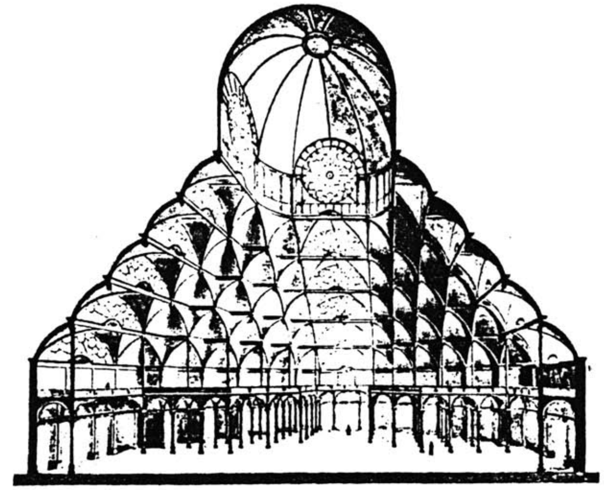
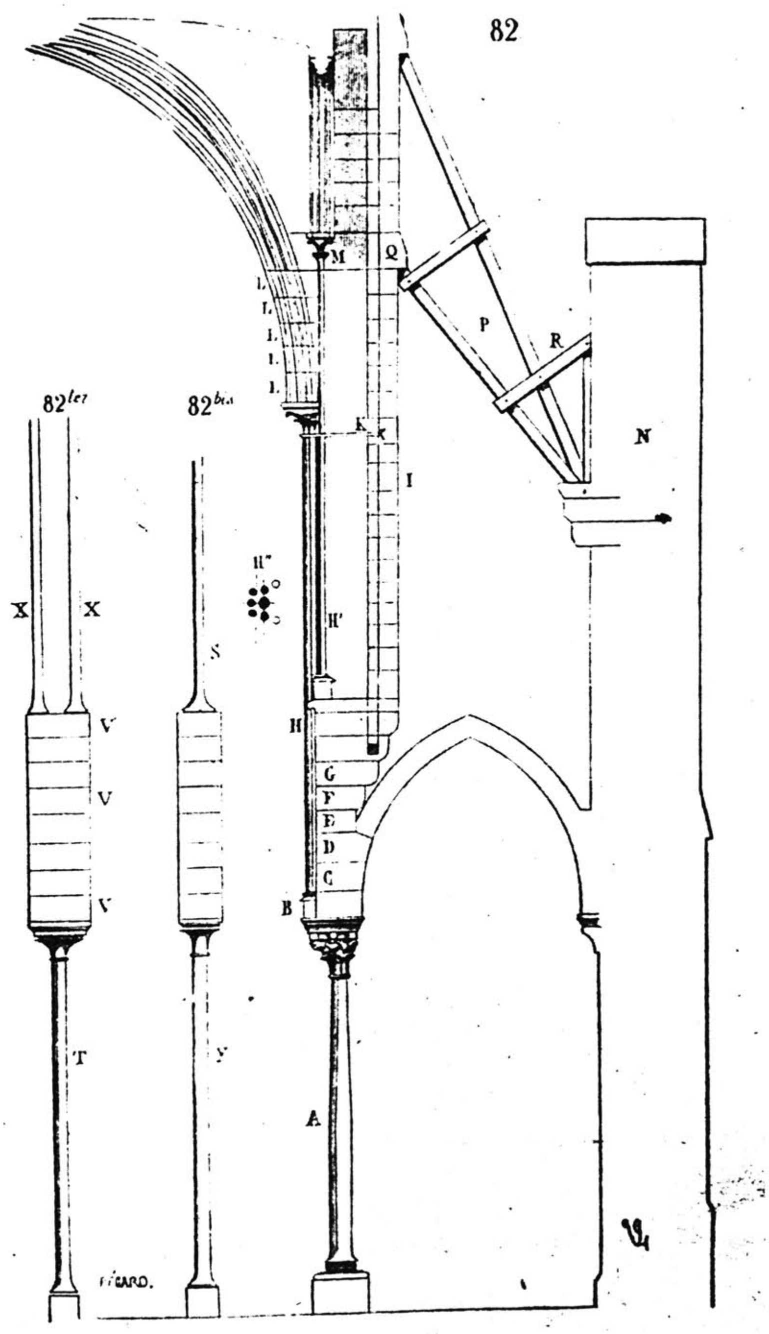
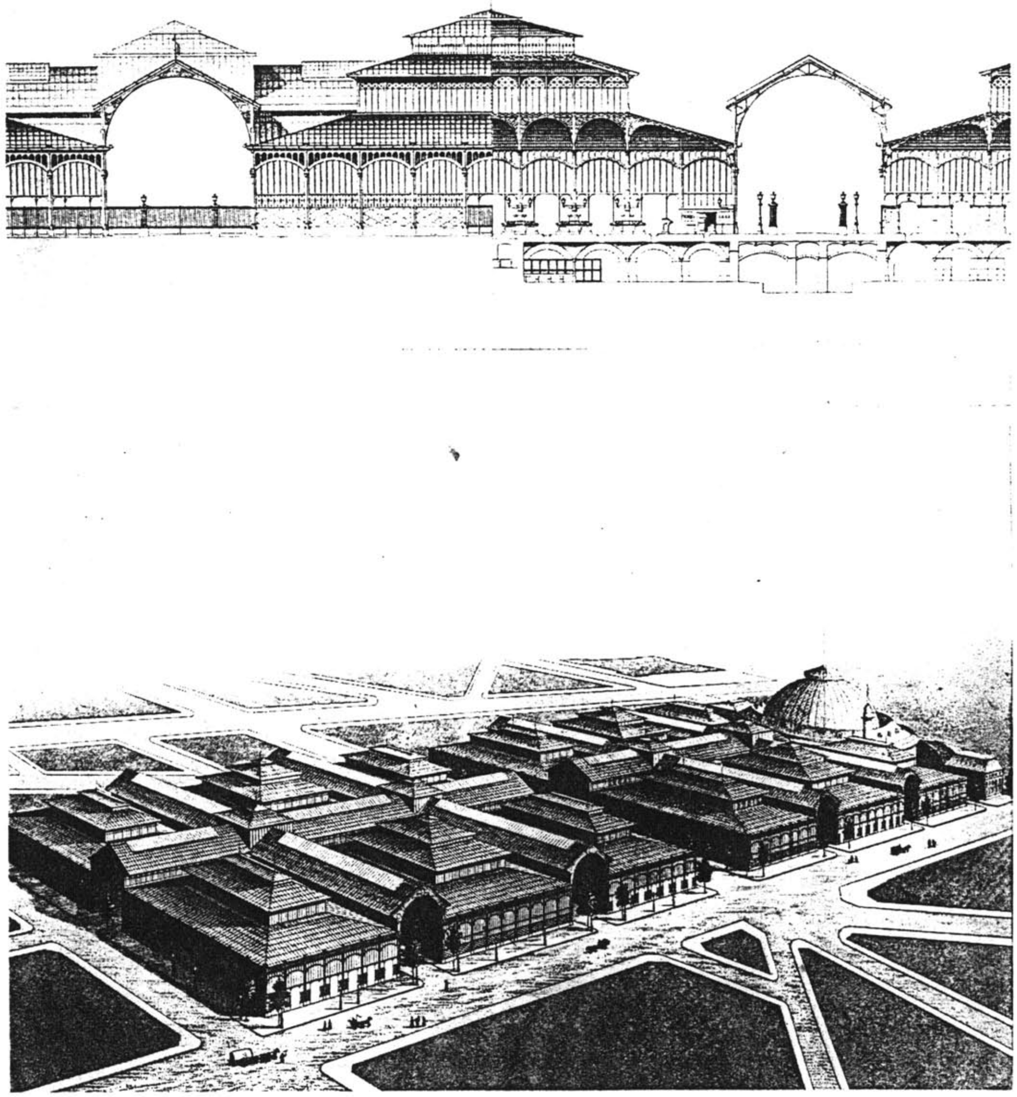


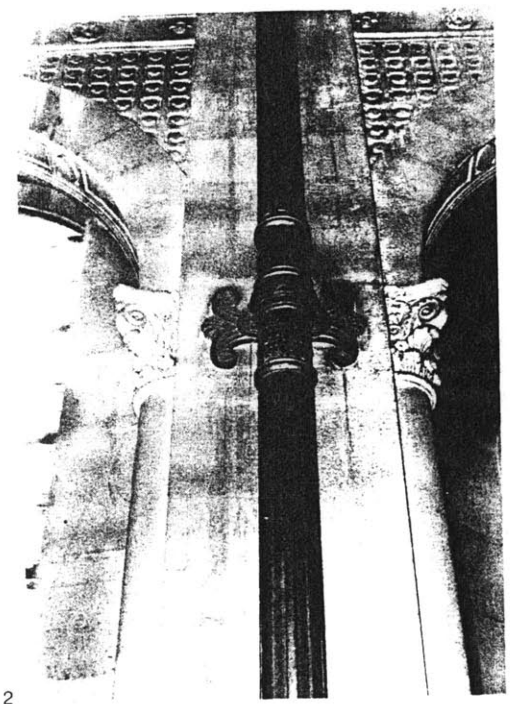
Fig. 15. Palais d'assemblée. Vue intérieure, H.C.I., pl. VII.



(fig. 98) Viollet-le-Duc, section of a gothic church, "Construction" in Dictionnaire. . . (1859)



(fig. 99) Victor Baltard, les Halles, Paris, 1854-1866



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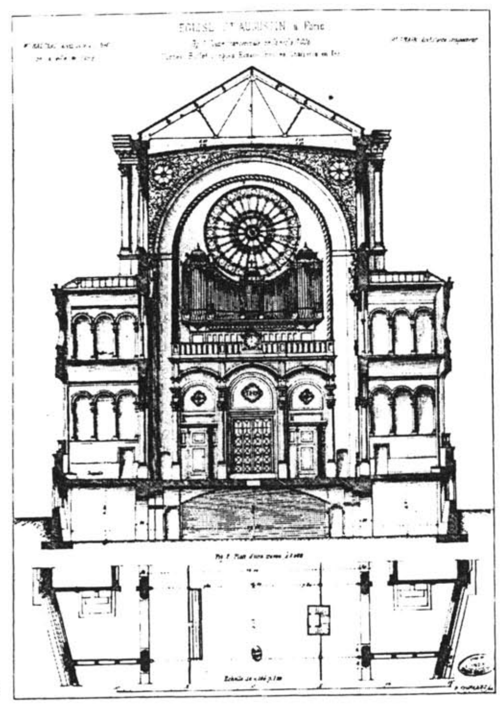
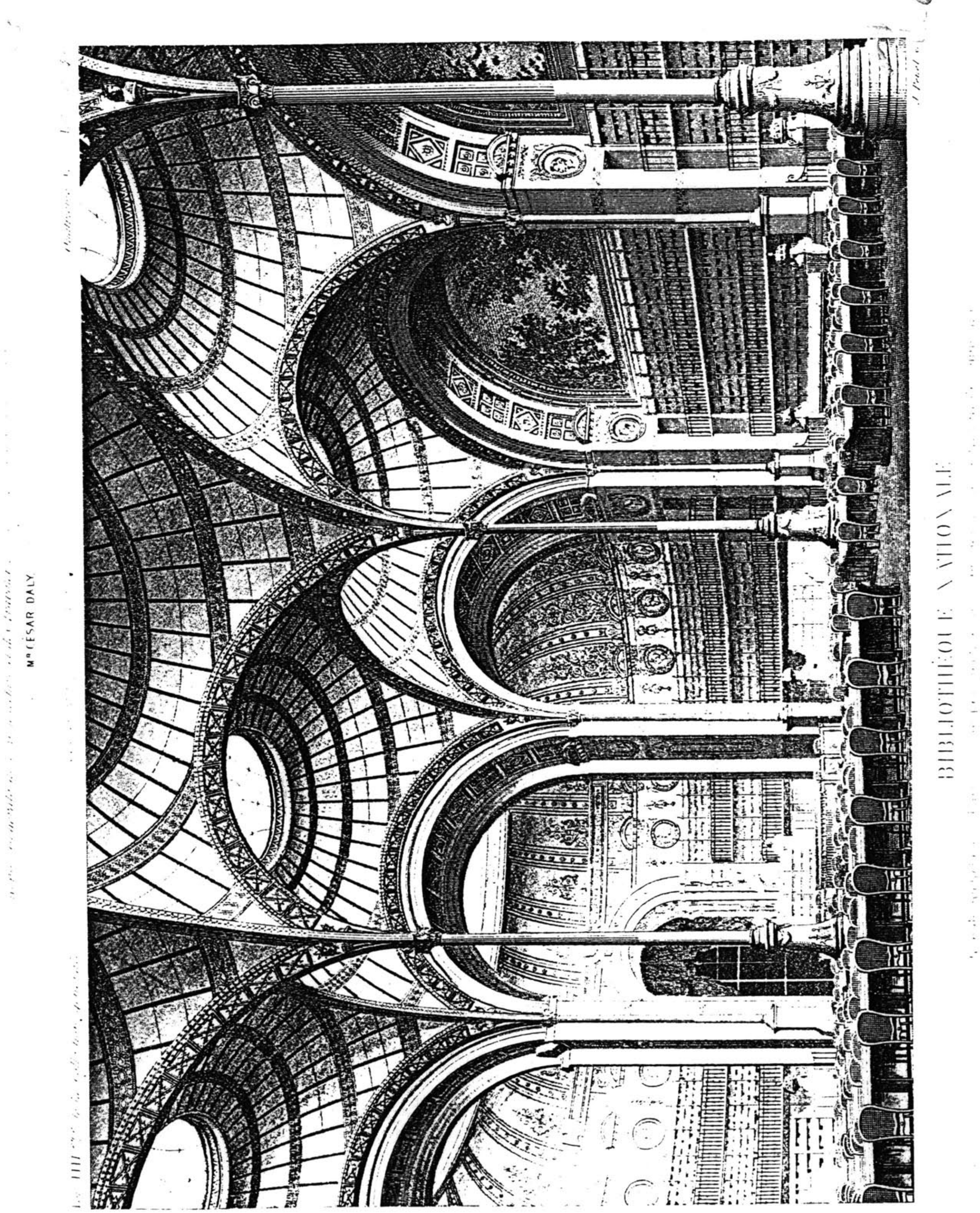


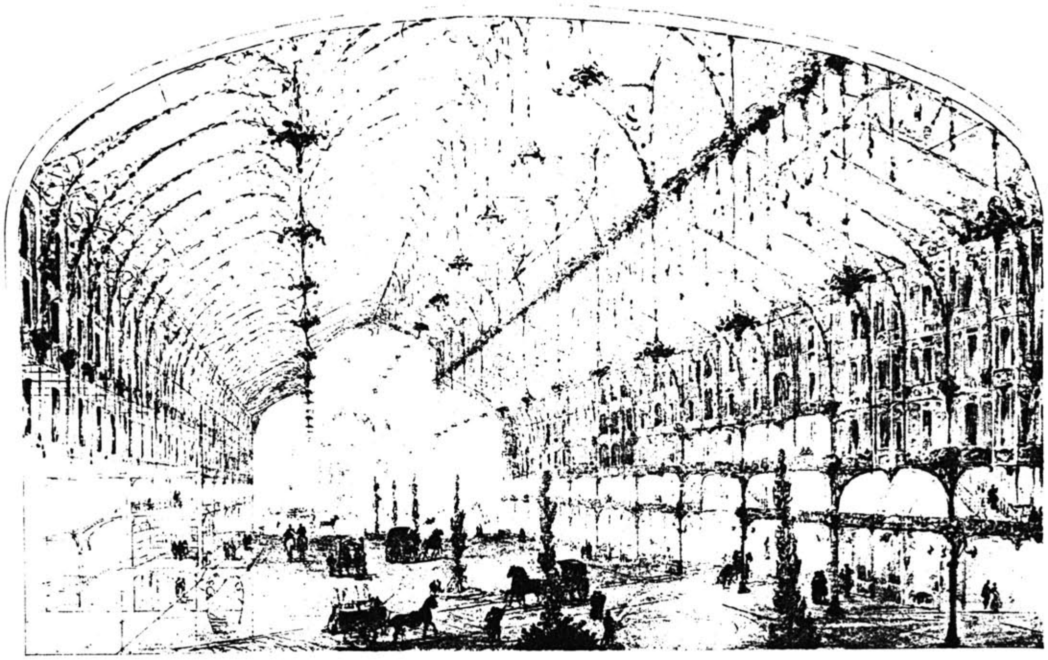
3

Paris: Church of Saint-Augustin, 1860-1871.
Architect: Victor Baltard.
2. Detail of an imbedded iron column.
3. Cross-section of the nave.
Nouvelles Annales de la Construction, 1872.

(fig. 100) Victor Baltard, church of St.-Augustin, 1860-1872



(fig. 101) Labrouste, bibliothèque Nationale , -1868, from Revue générale de l'architecture



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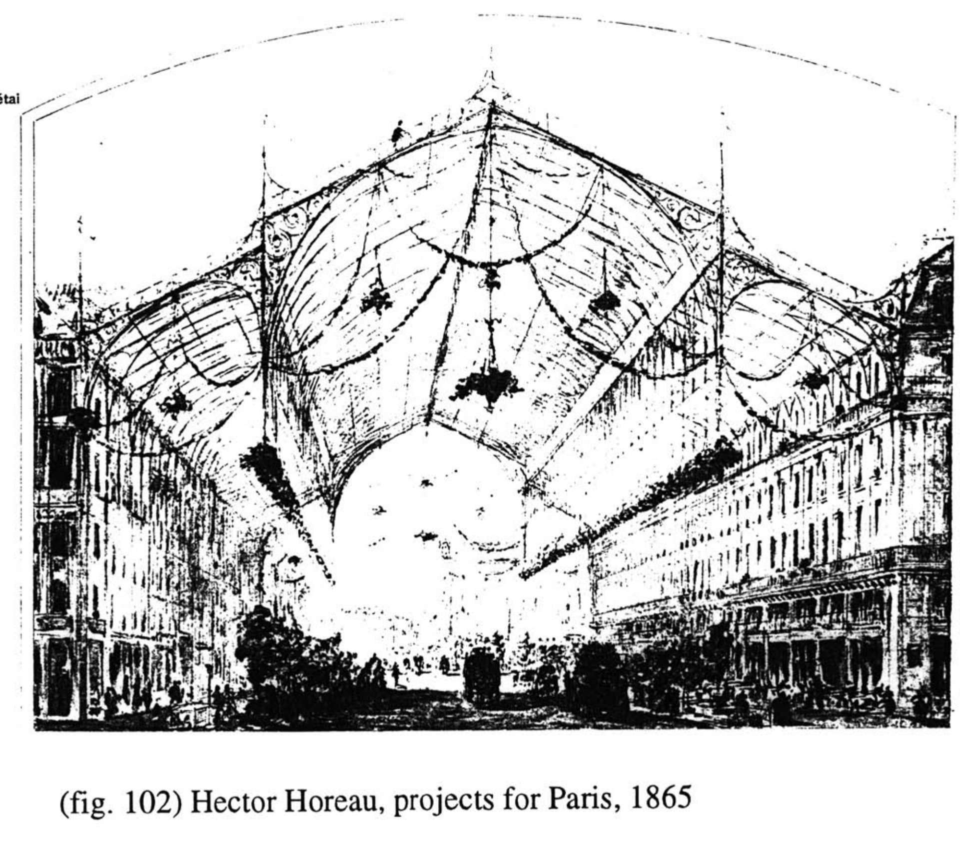


(fig. 102) Hector Horeau, projects for Paris, 1865

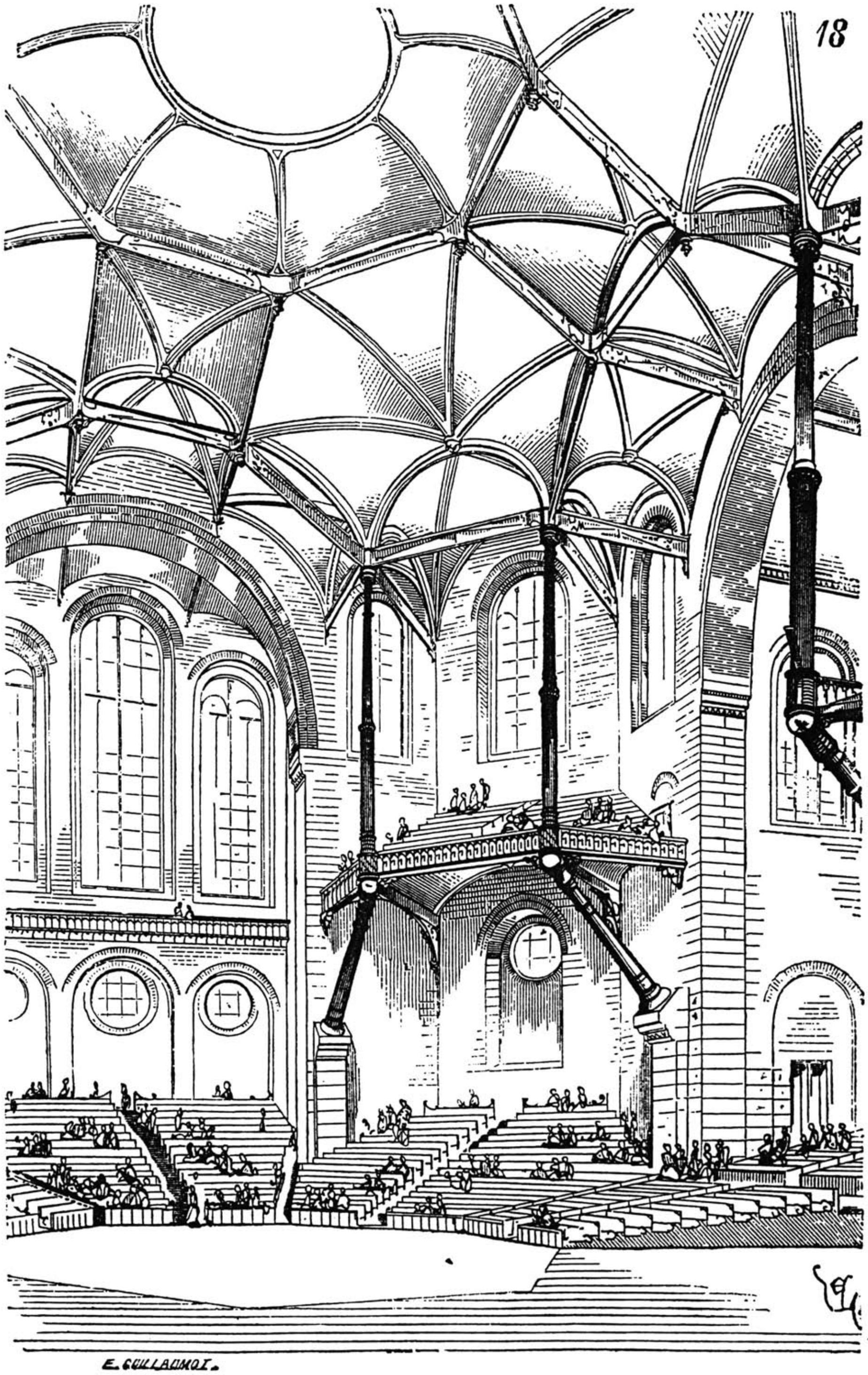
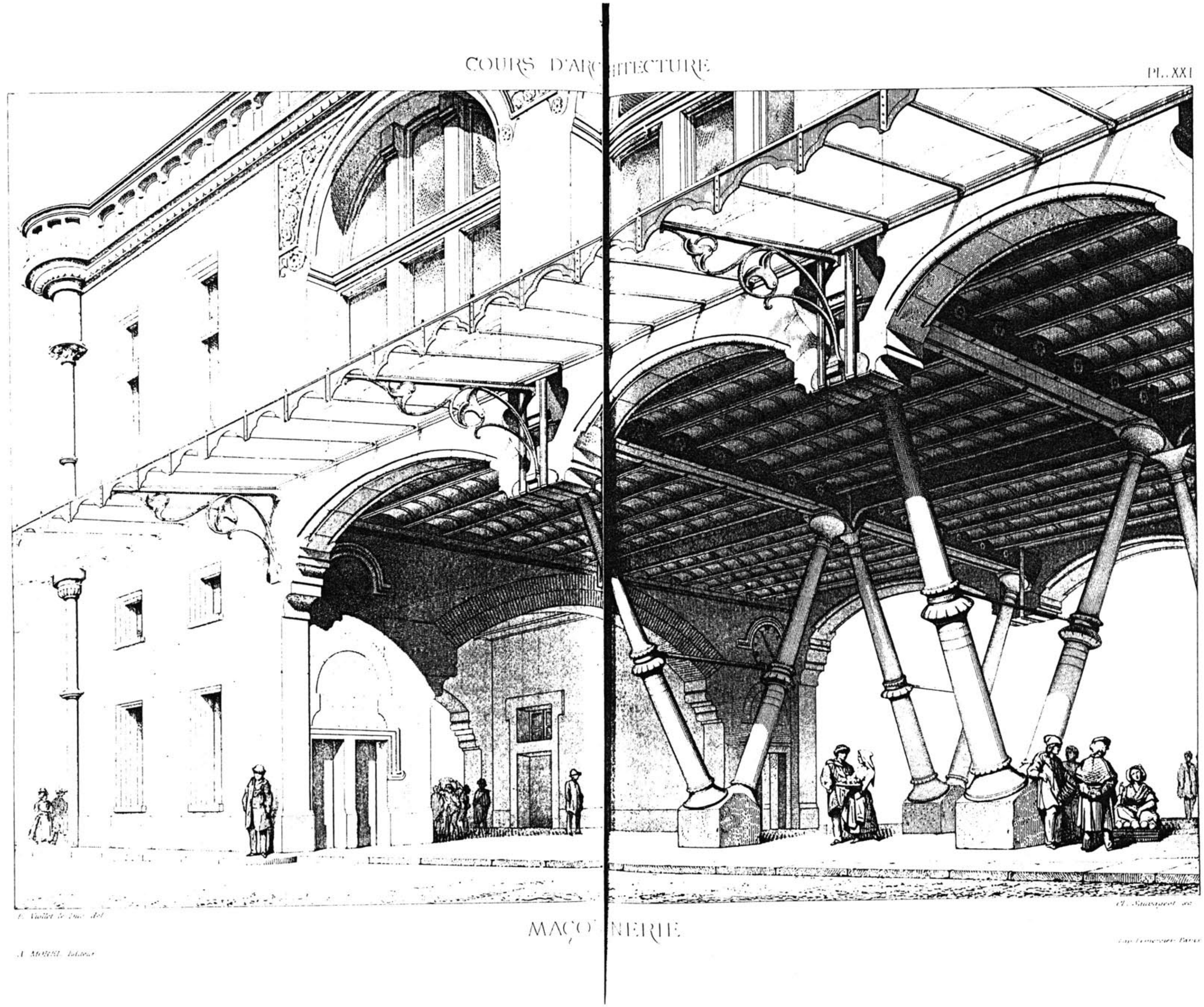


FIG. 18.—Iron and Masonry.—Vaulting of large Spaces.

(fig. 103) Viollet-le-Duc, hall for 3000 people, 1864



(fig. 104) Viollet-le-Duc, design for covered iron market hall, 1864

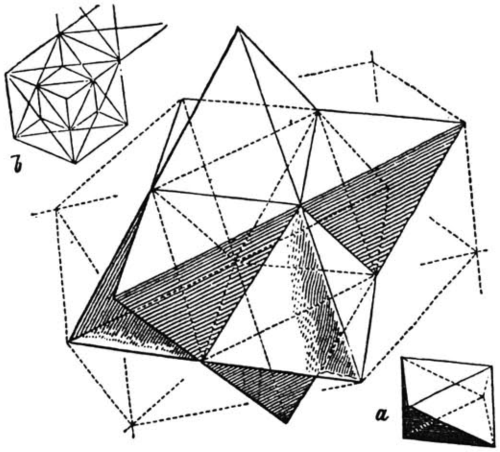
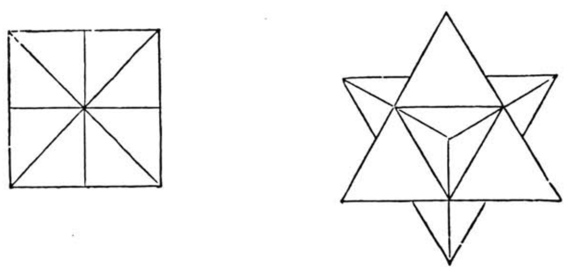


Figure 2

Figure 3



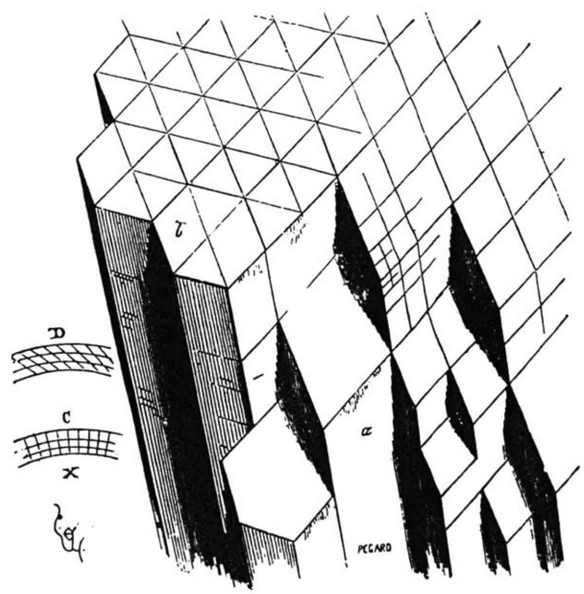


Figure 4

(fig. 105) Viollet-le-Duc, from "Style" in <u>Dictionnaire</u>

(fig. 106) César Daly, Revue générale de l'architecture (1869)

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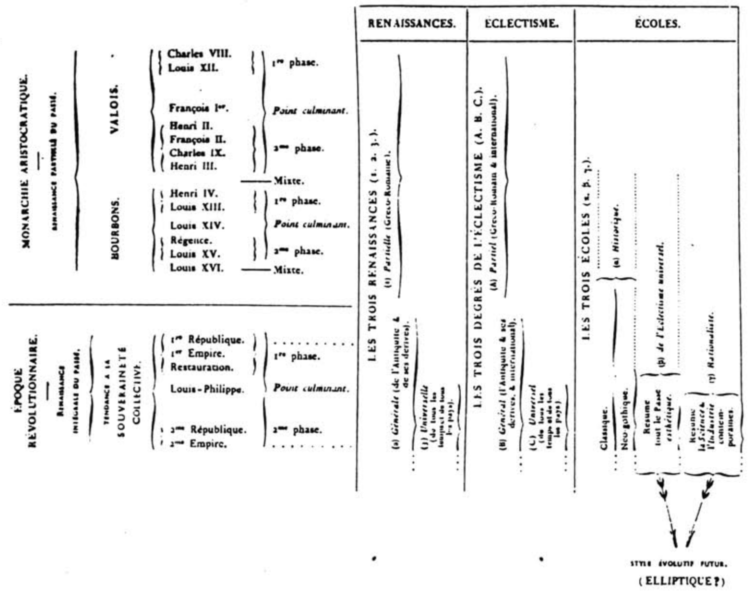
PÉRIODE DE TRANSITION

DE LA SOCIÉTÉ ET DE L'ARCHITECTURE FRANÇAISE MODERNES.

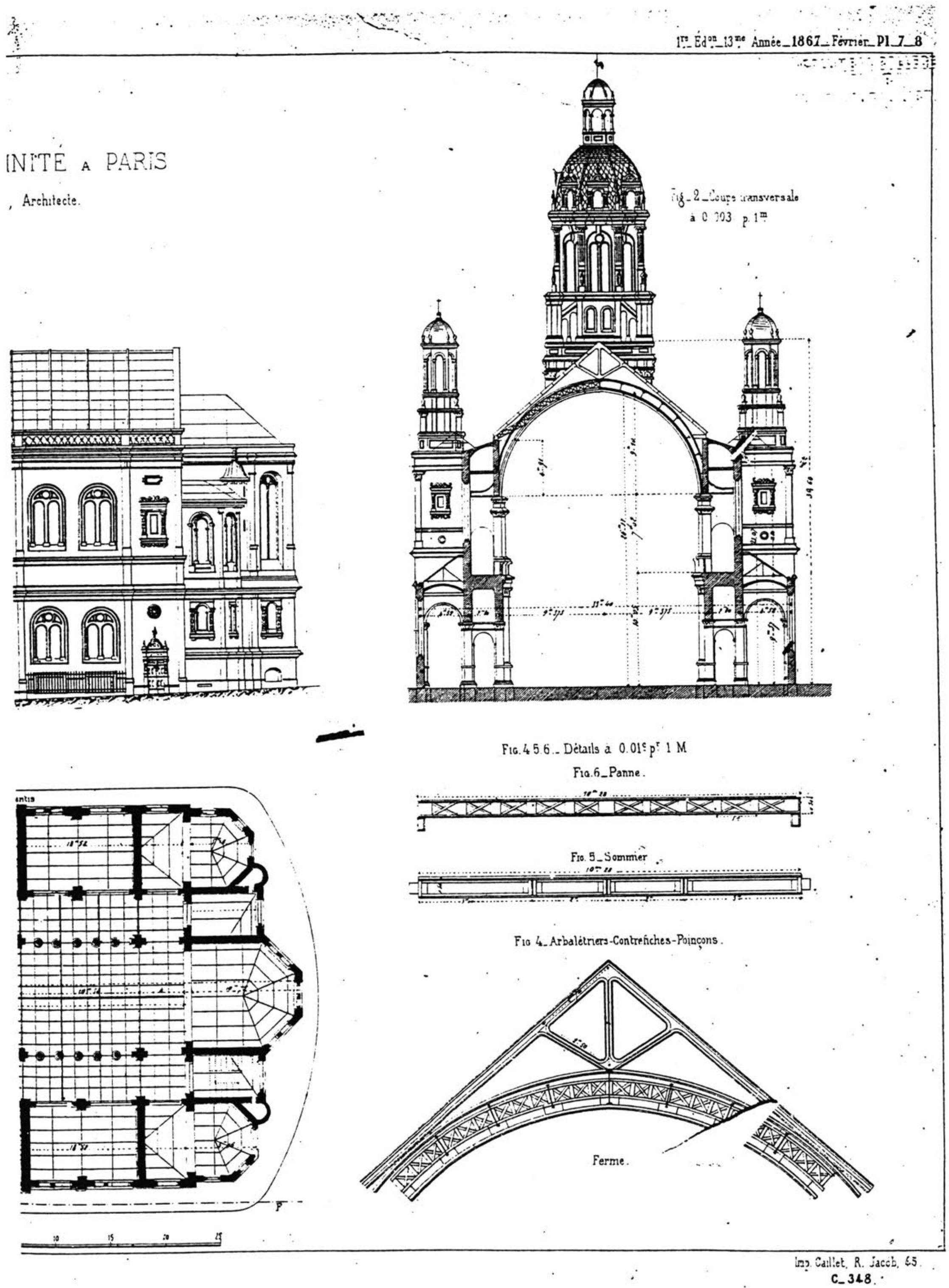


TABLEAU

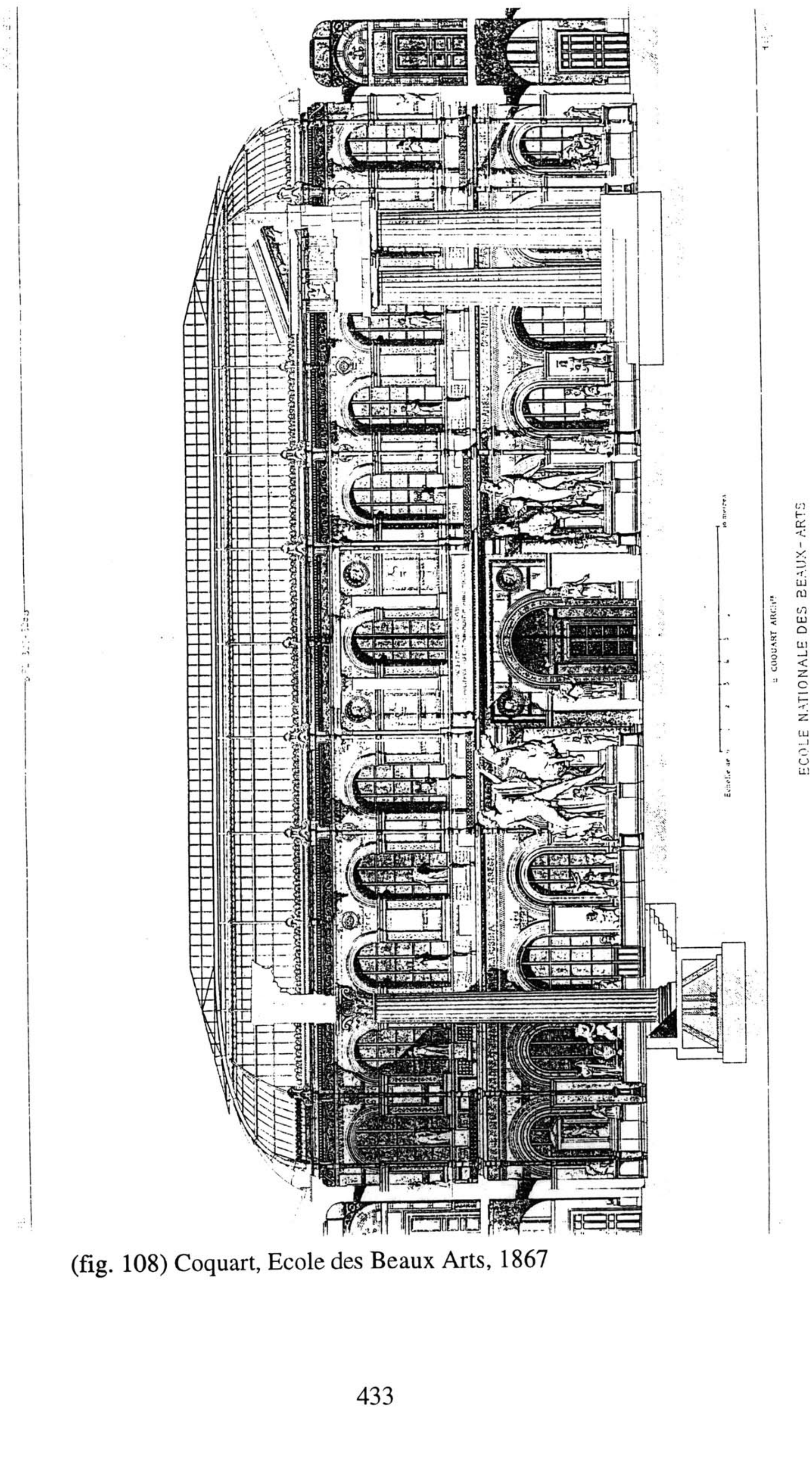
DE LA GÉNÉRATION GÉOMÉTRIQUE ET SUCCESSIVE DES STYLES-TYPES D'ARCHITECTURE[1].

			STYLES.	MOUVEMENT Géométrique des Styles.	SYSTÈME DES IDÉES SOCIALES: Religion.	Politique.	Droit.	Etc.	Etc.
STYLES PRIMITIFS.	LIGNE DROITE.	Base géométrique, constructive & esthétique: La ligne droite & ses combinaisons. Élévations[2]: Surfaces planes[3].	1° L'ÉGYPTIEN.	Evolution rectiligne de premier degré.	Polythéisme.[4]	Unité puissante, Liberté nulle. Etc., &c., &c.	•	•	•
			2° LE GREC.	Evolution rectiligne de deuxième degré.		Liberté puissante, Unité nulle. Etc., &c., &c.	•	•	•
	MIXTE.		LE ROMAIN.	*Transition des styles rectilignes aux styles curvilignes.*		Mixte.	•		
STYLES SECONDAIRES.	ARC DE CERCLE.	Base géométrique, constructive & esthétique: L'Arc de cercle & ses composés. Élévations: Surfaces planes, cylindriques; Dômes.	1° LE BYZANTIN (en Orient). LE ROMAN (en Occident).	Evolutions curvilignes simples, du premier degré.	Monothéisme.	L'Ordre par l'Autorité compressive.			
			2° L'OGIVAL (en Orient). L'OGIVAL (en Occident).	Evolutions curvilignes simples, du deuxième degré.					
	MIXTE.		LE MODERNE (depuis la Renaissance jusqu'à nos jours).	*Transition des styles curvilignes simples aux styles curvilignes supérieurs.*		Mixte.			
STYLES TERTIAIRES.	ELLIPSE.	Base géométrique, constructive & esthétique: Les Arcs elliptiques & leurs composés. Élévations: Surfaces planes, cylindriques; Dômes, &c.	1° L'ELLIPTIQUE (?)	Evolution curviligne supérieure, du premier degré.		L'Ordre par la Liberté.			
			2° (?)	. . . .					

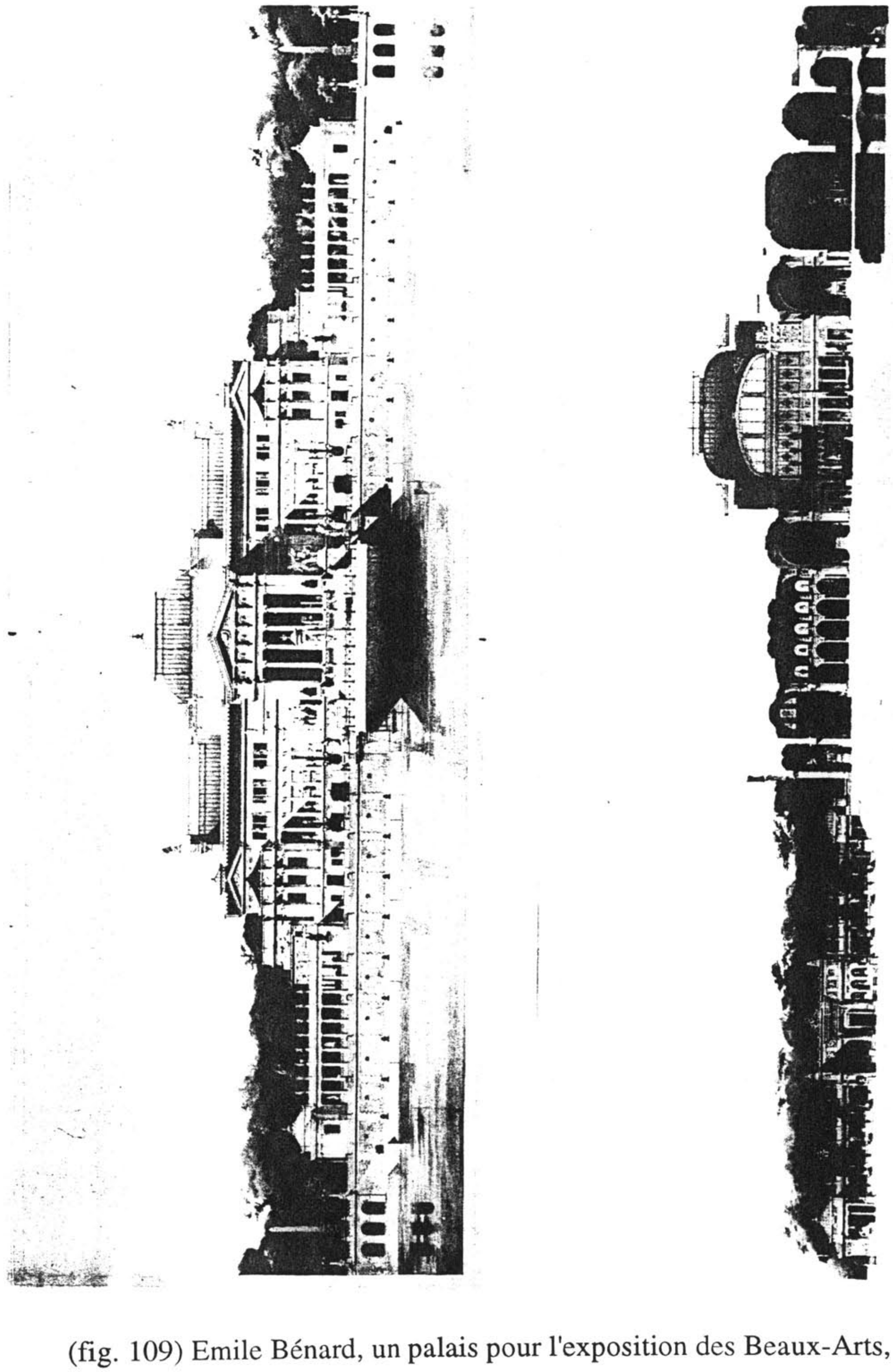
(Voir les notes à la page ci-contre.)



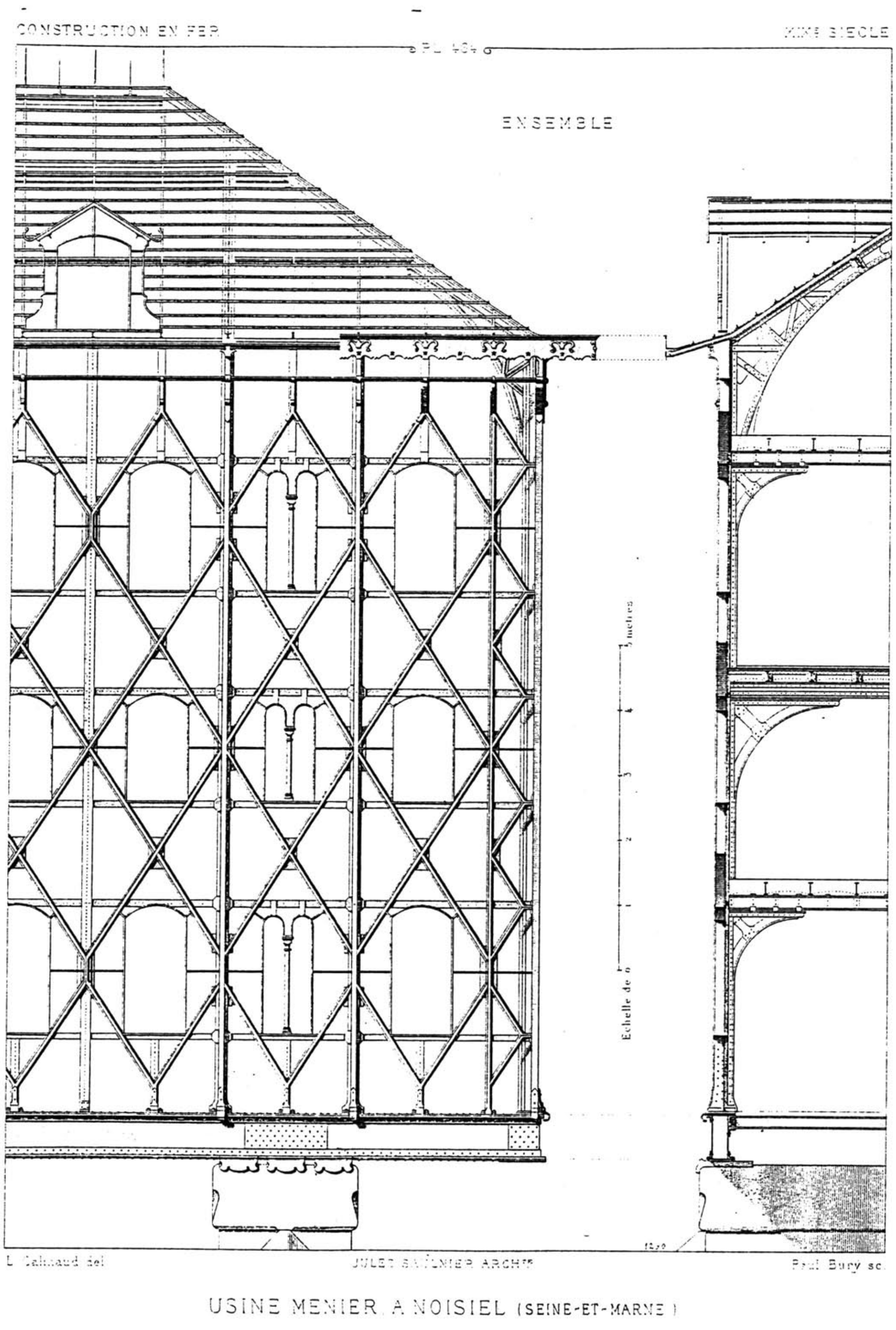
(fig. 107) Ballu, trinity church, 1867, from <u>Nouvelles Annales de la Construction</u>



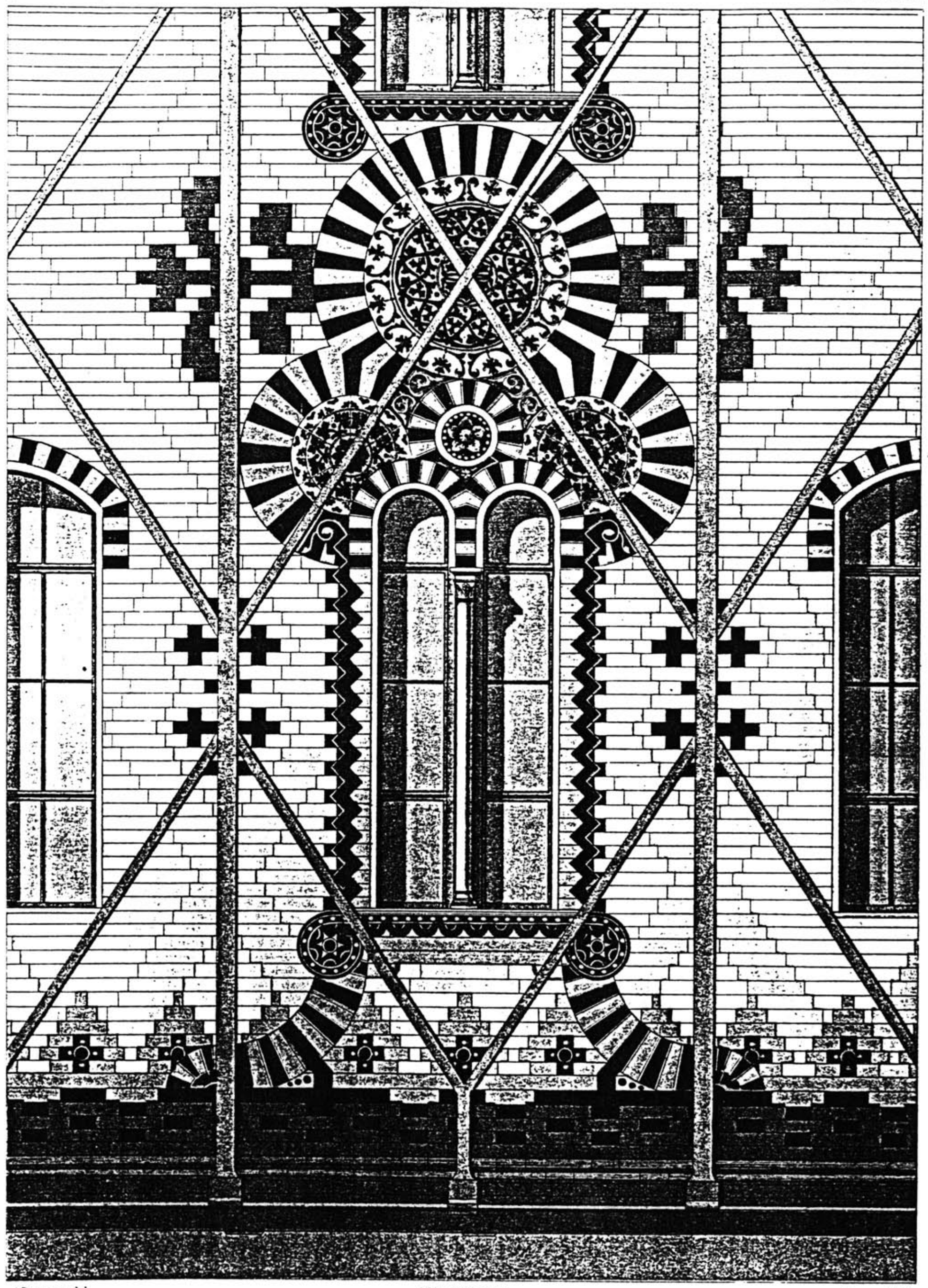
(fig. 108) Coquart, Ecole des Beaux Arts, 1867



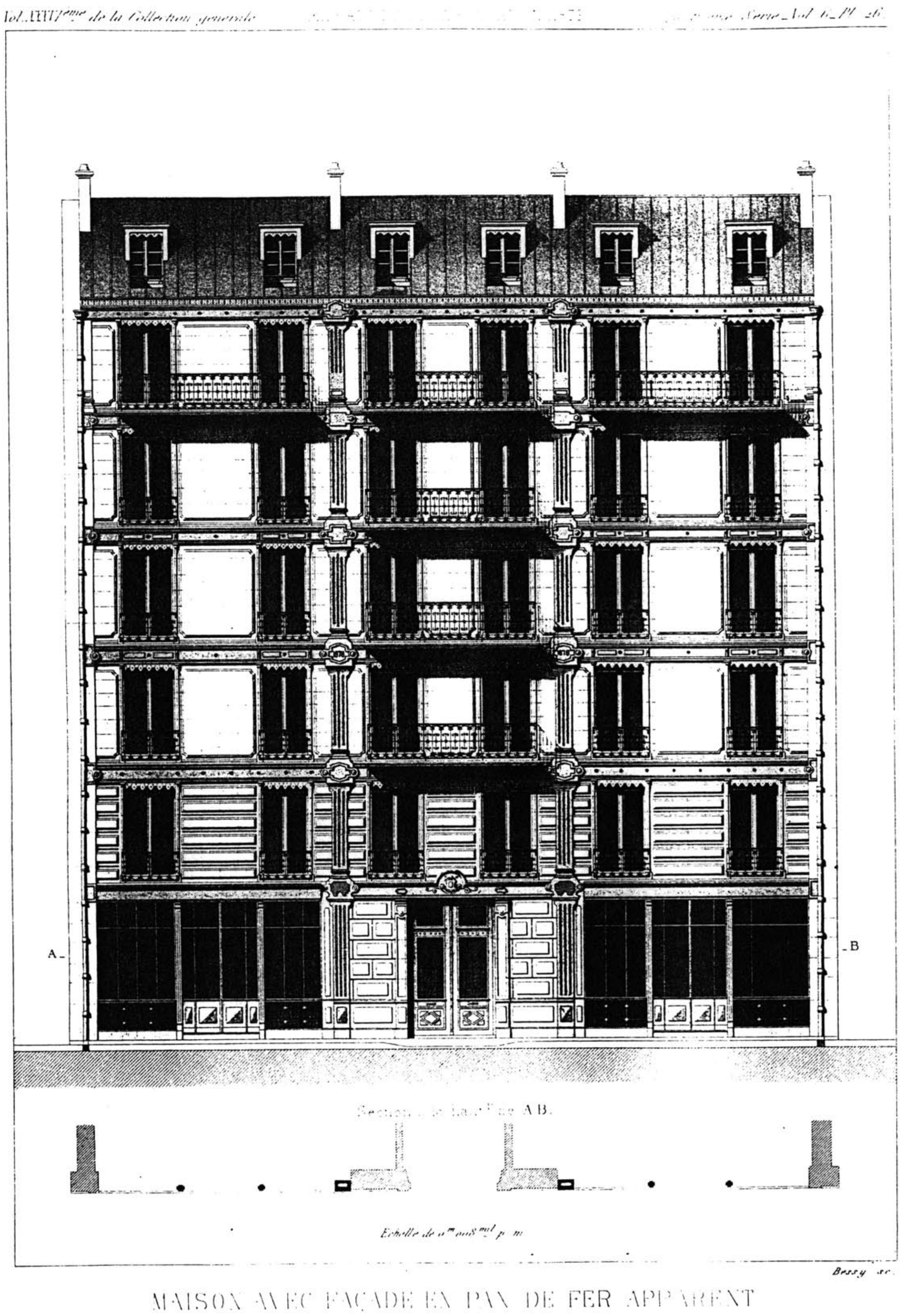
(fig. 109) Emile Bénard, un palais pour l'exposition des Beaux-Arts, 1867,



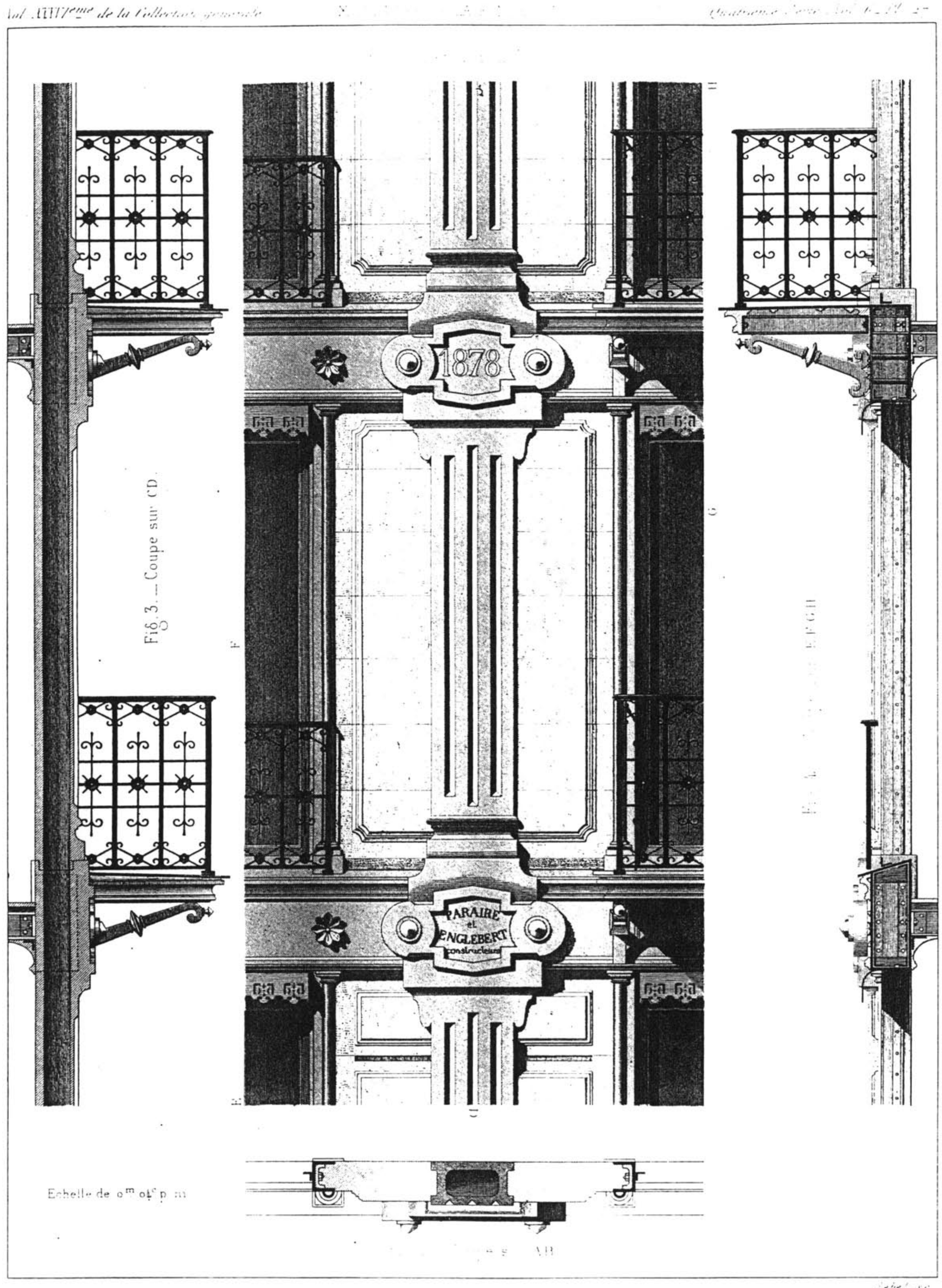
(fig. 110) Saulnier, chocolate factory at Noisiel, 1876, from <u>Encycopédie d'architecture</u>



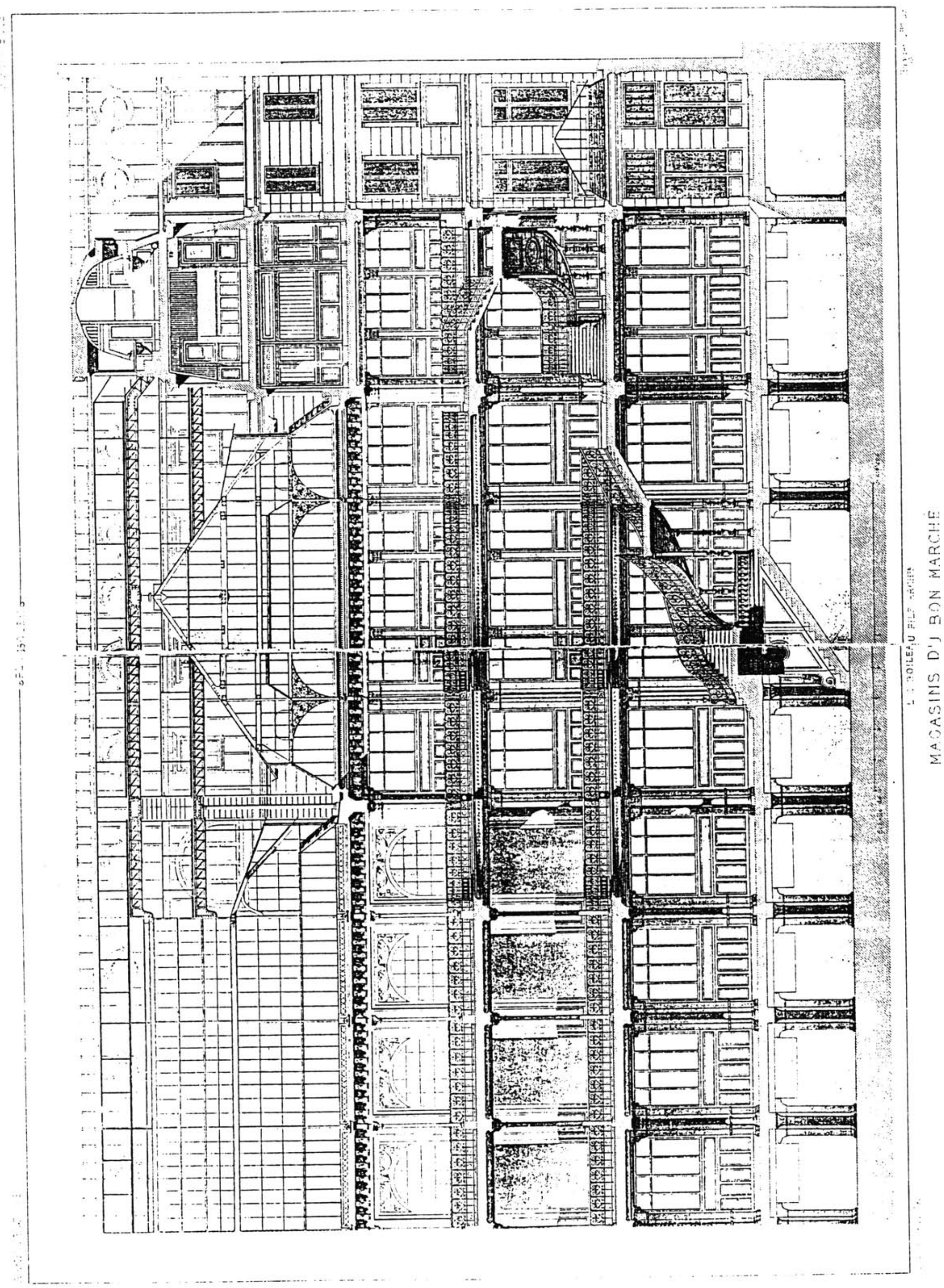
(fig. 111) Saulnier, detail of the facade of chocolate factory at Noisiel, 1876



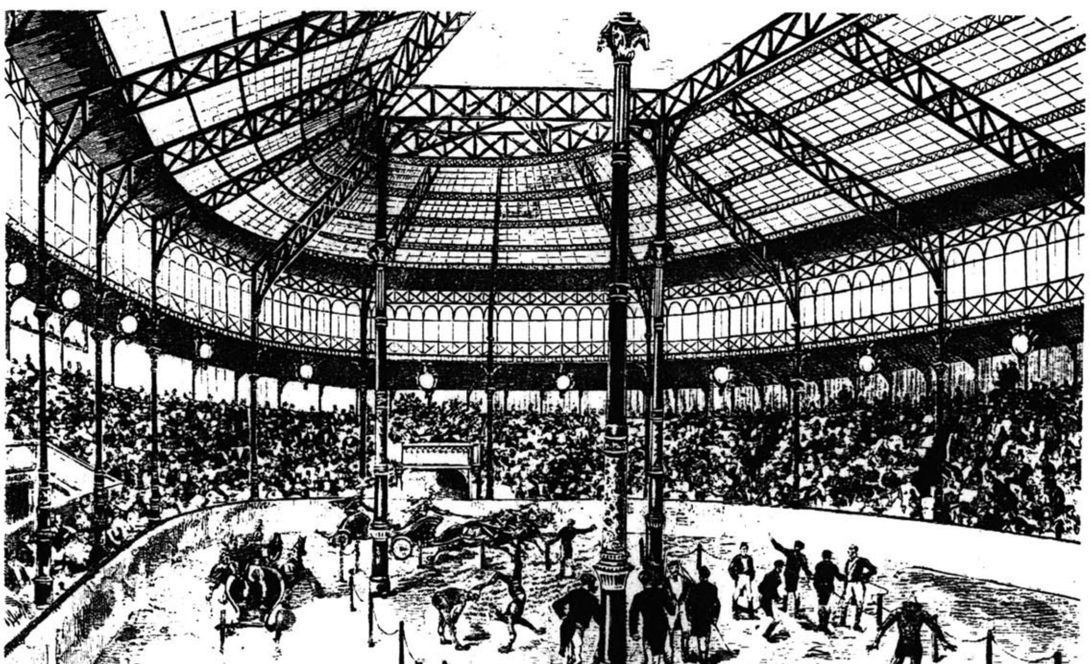
(fig. 112) *Pan de fer* apartment, 1878, Revue générale de l'architecture



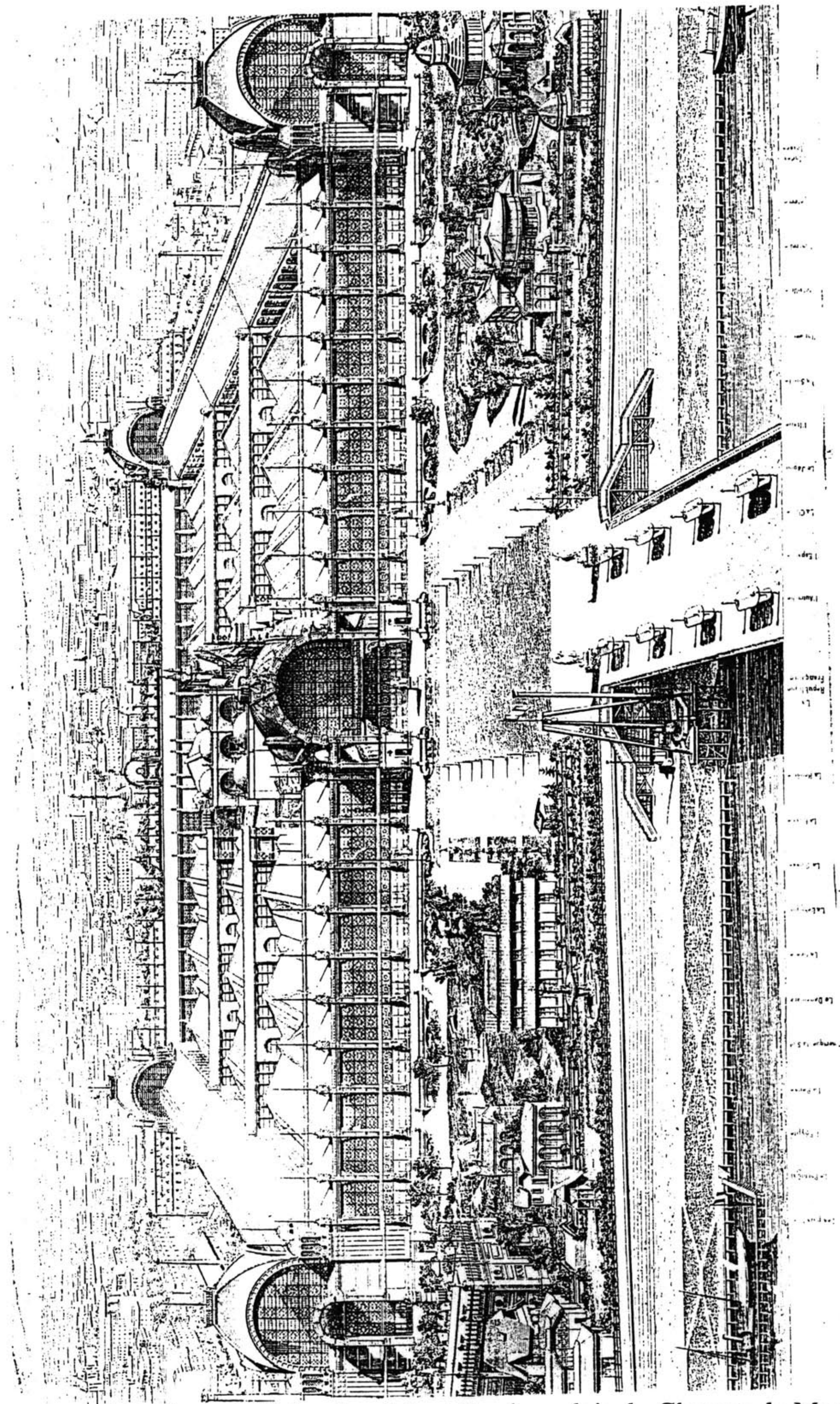
(fig. 113) *Pan de fer* apartment, 1878, detail, Revue générale de l'architecture



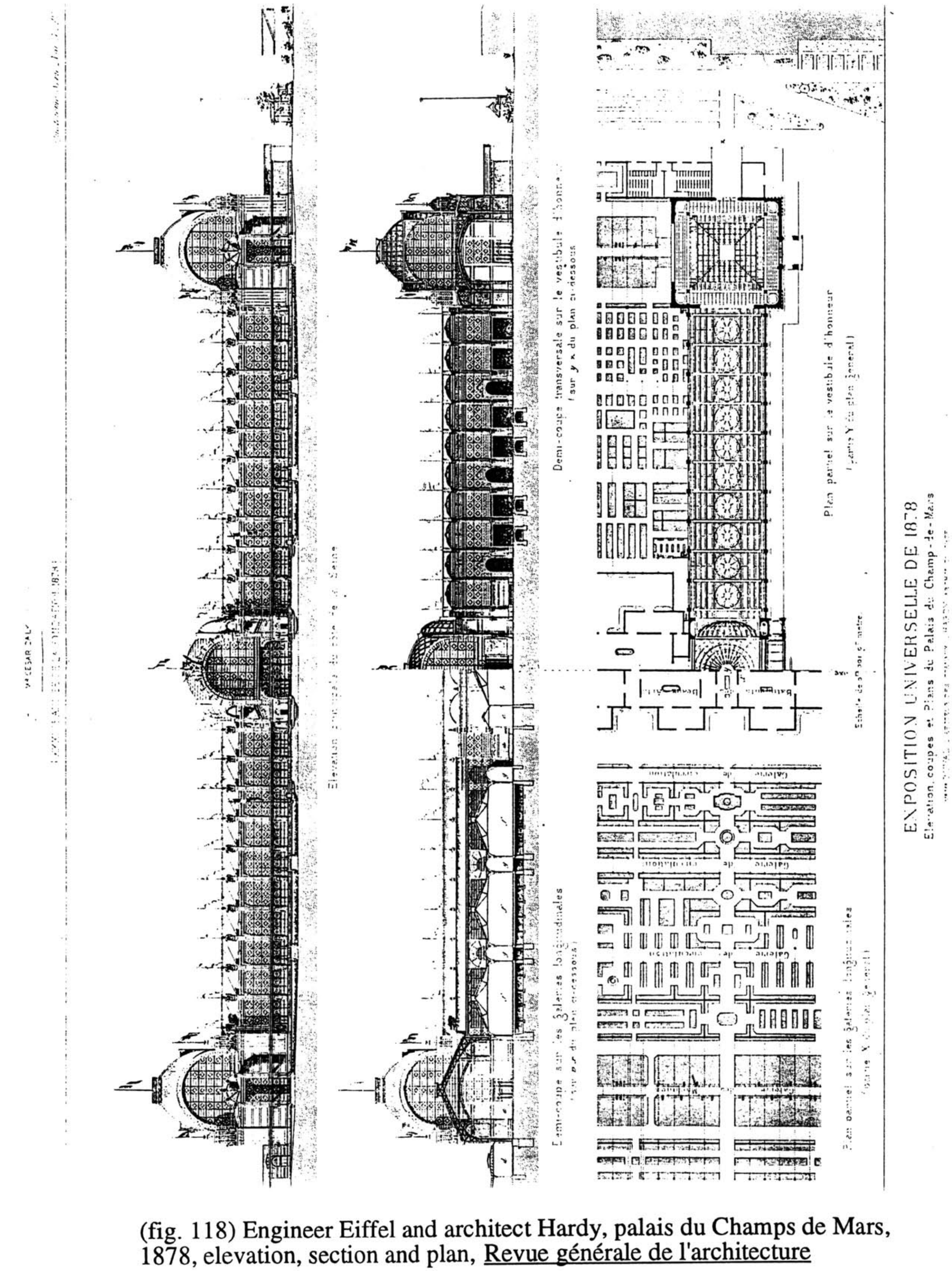
(fig. 114) L.-C. Boileau, grand staircase of the department store, Bon Marché, 1876, Encyclopédie d'architecture



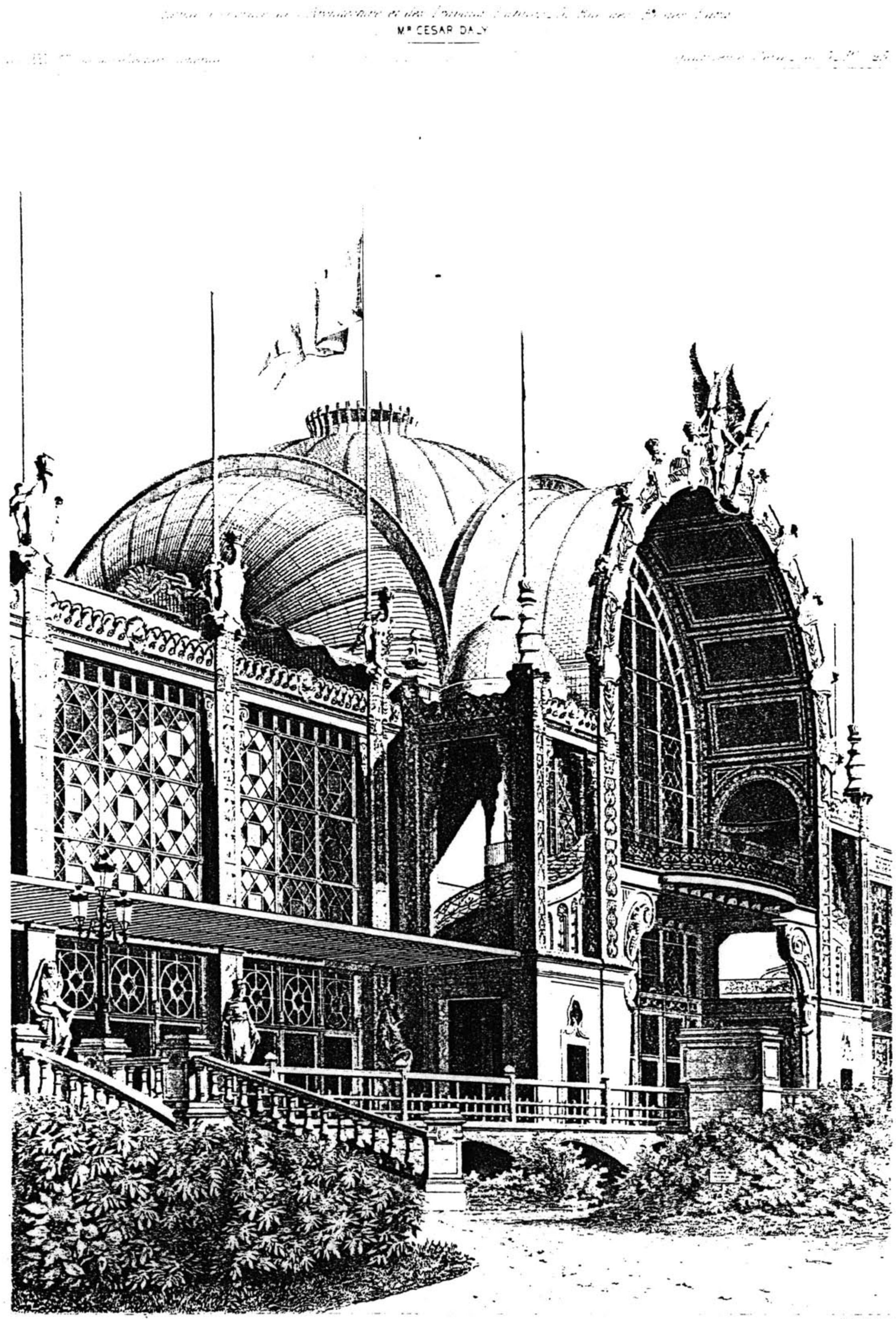
(fig. 115) Claude Monet, gare de St.-Lazare, 1877
(fig. 116) Hippodrome, 1877



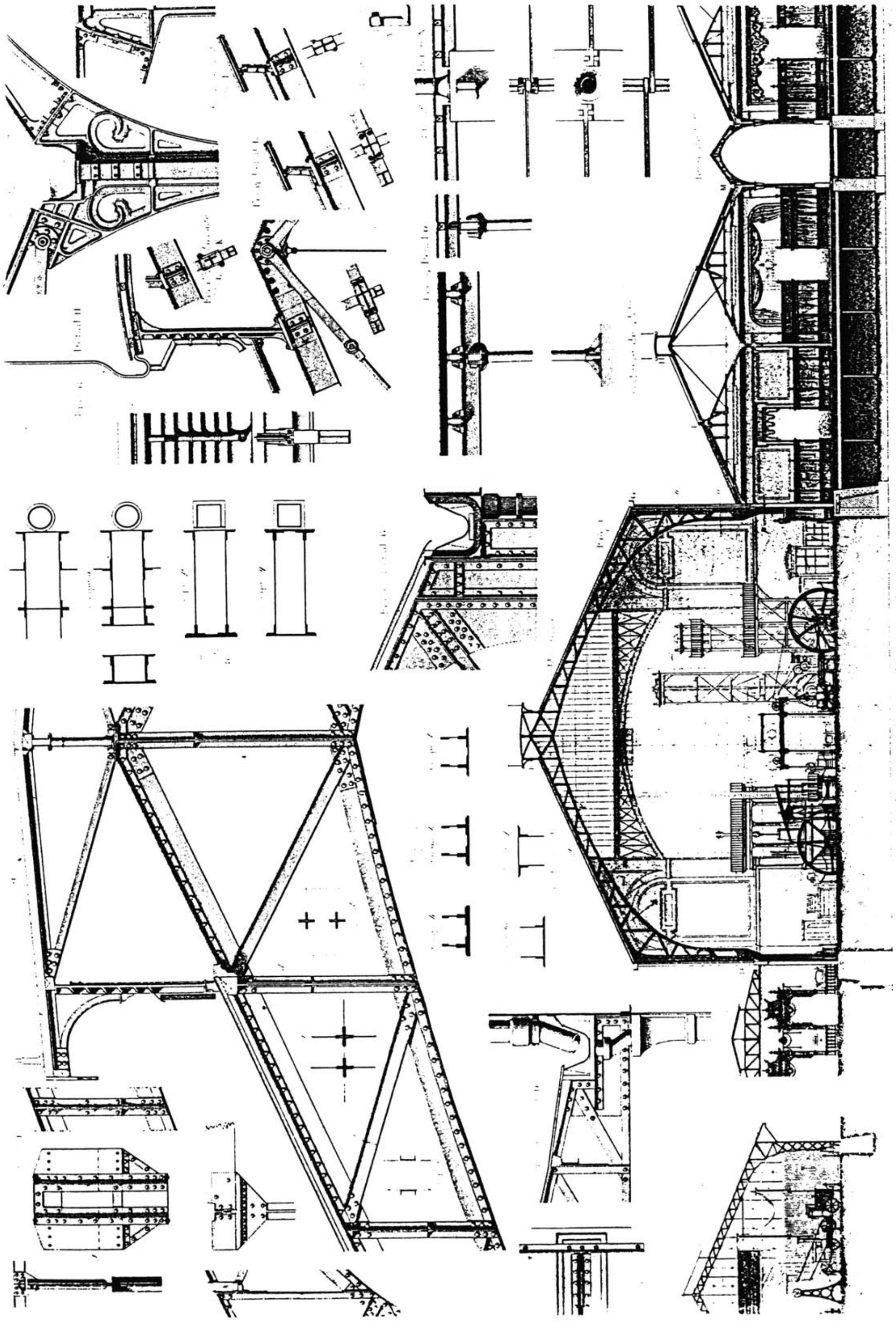
(fig. 117) Engineer Eiffel and architect Hardy, palais du Champs de Mars, 1878, bird eye's view



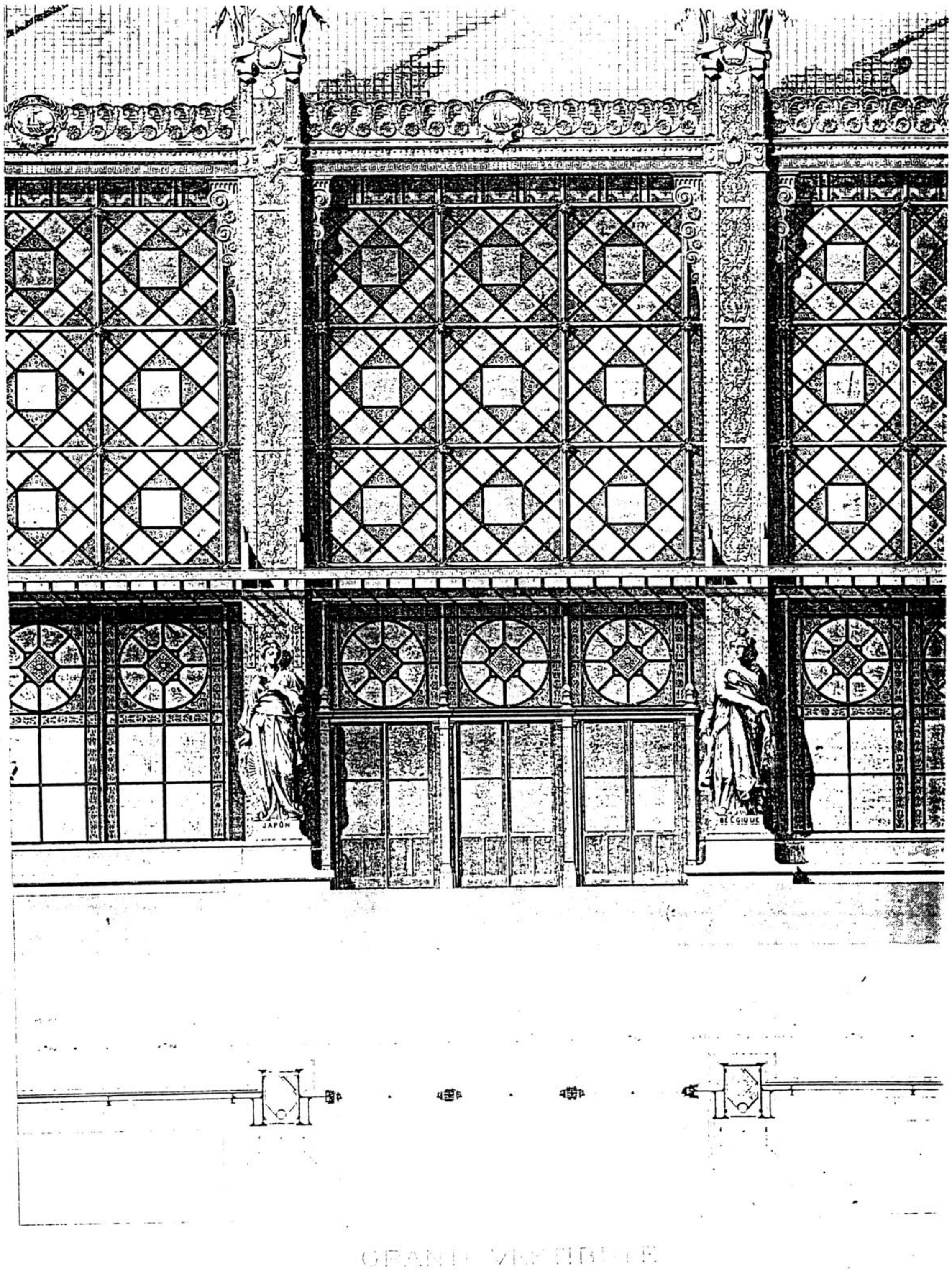
(fig. 118) Engineer Eiffel and architect Hardy, palais du Champs de Mars, 1878, elevation, section and plan, Revue générale de l'architecture



(fig. 119) Engineer Eiffel and architect Hardy, Palais du Champs de Mars, 1878, detail, Revue générale de l'architecture

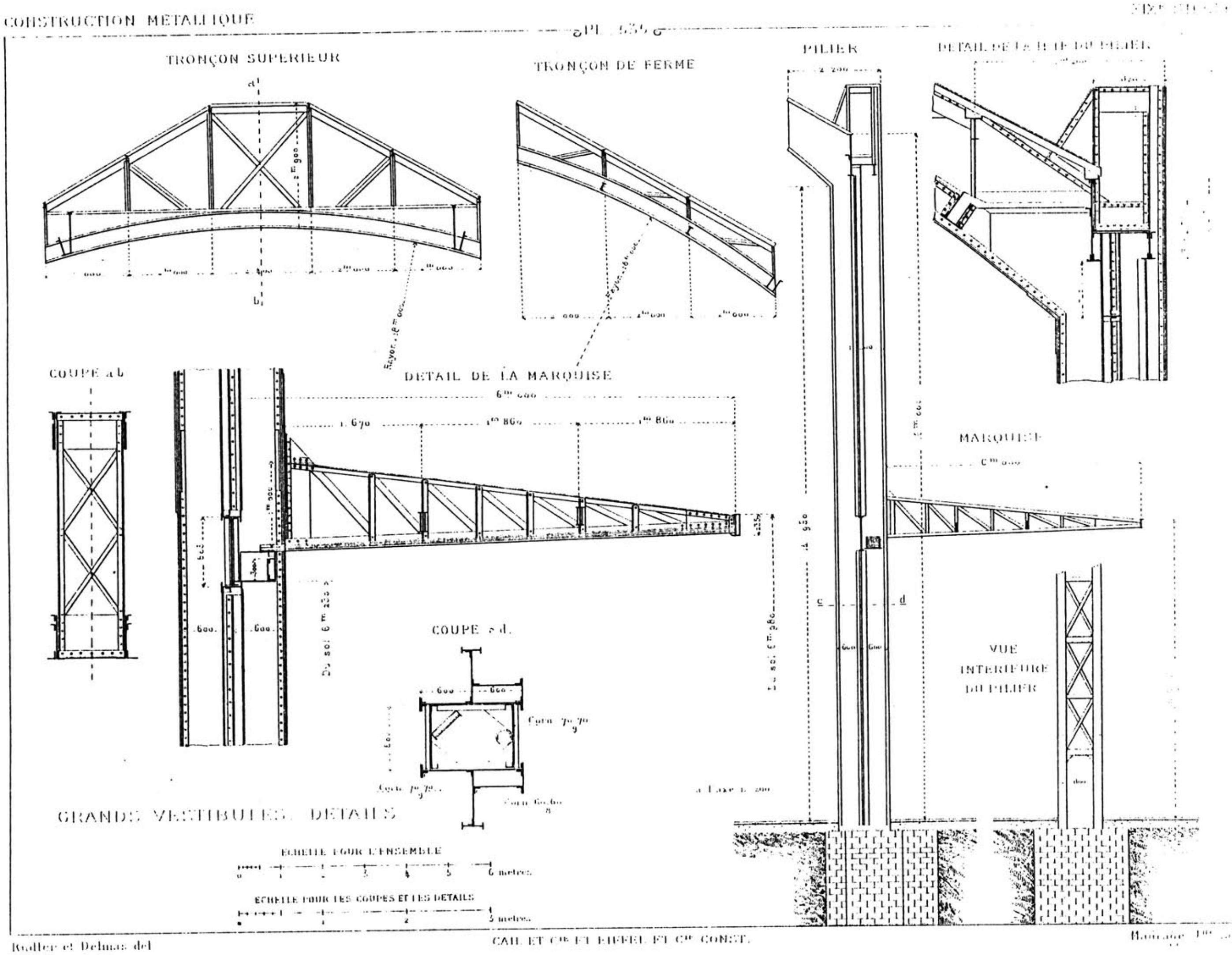


(fig. 120) Geleries des Machines, palais du Champs de Mars, 1878



(fig. 121) Palais du Champs de Mars, 1878, detail of the facade of the vestibule

ENCYCLOPEDIE D'ARCHITECTURE

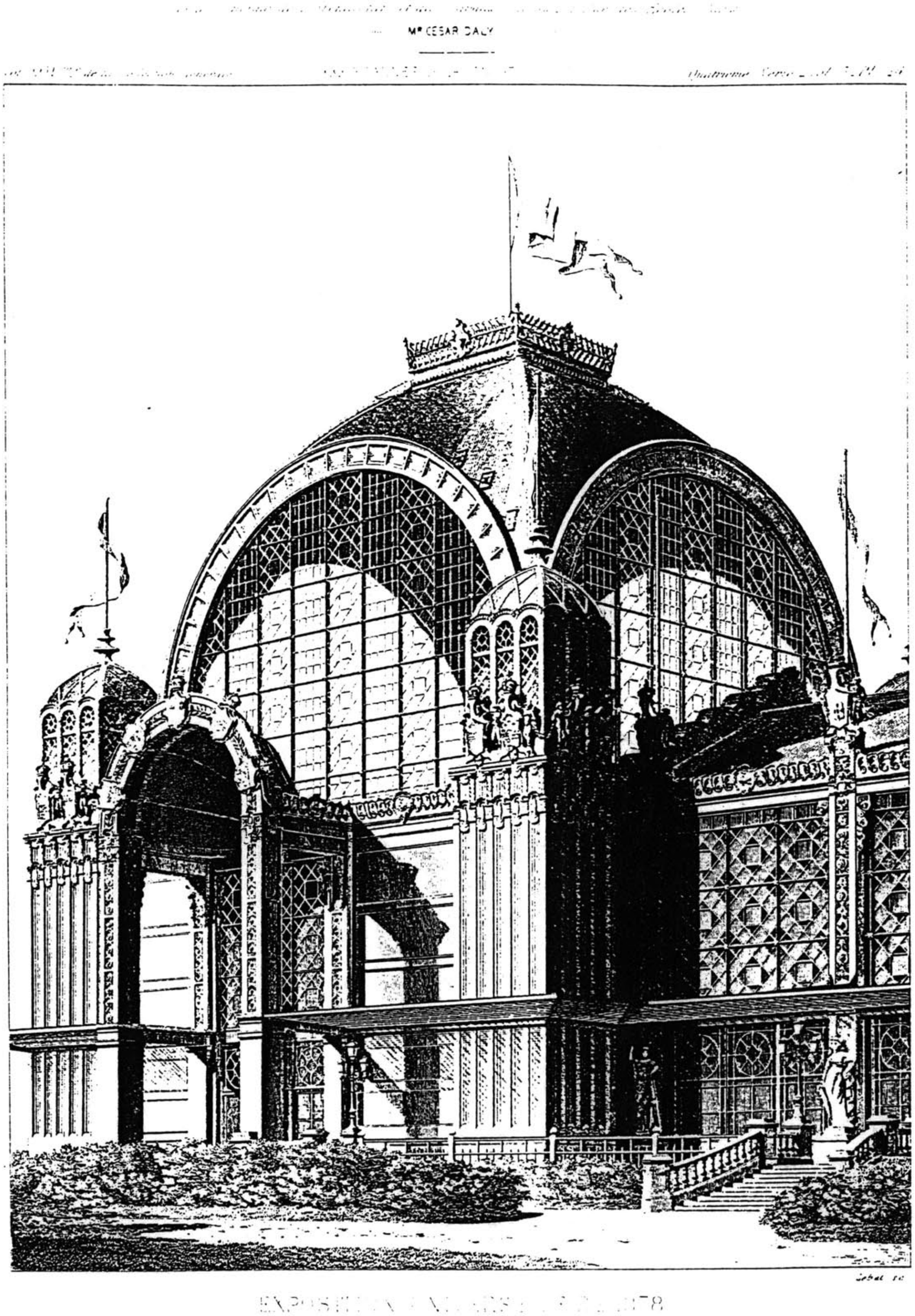


EXPOSITION UNIVERSELLE DE 1878.

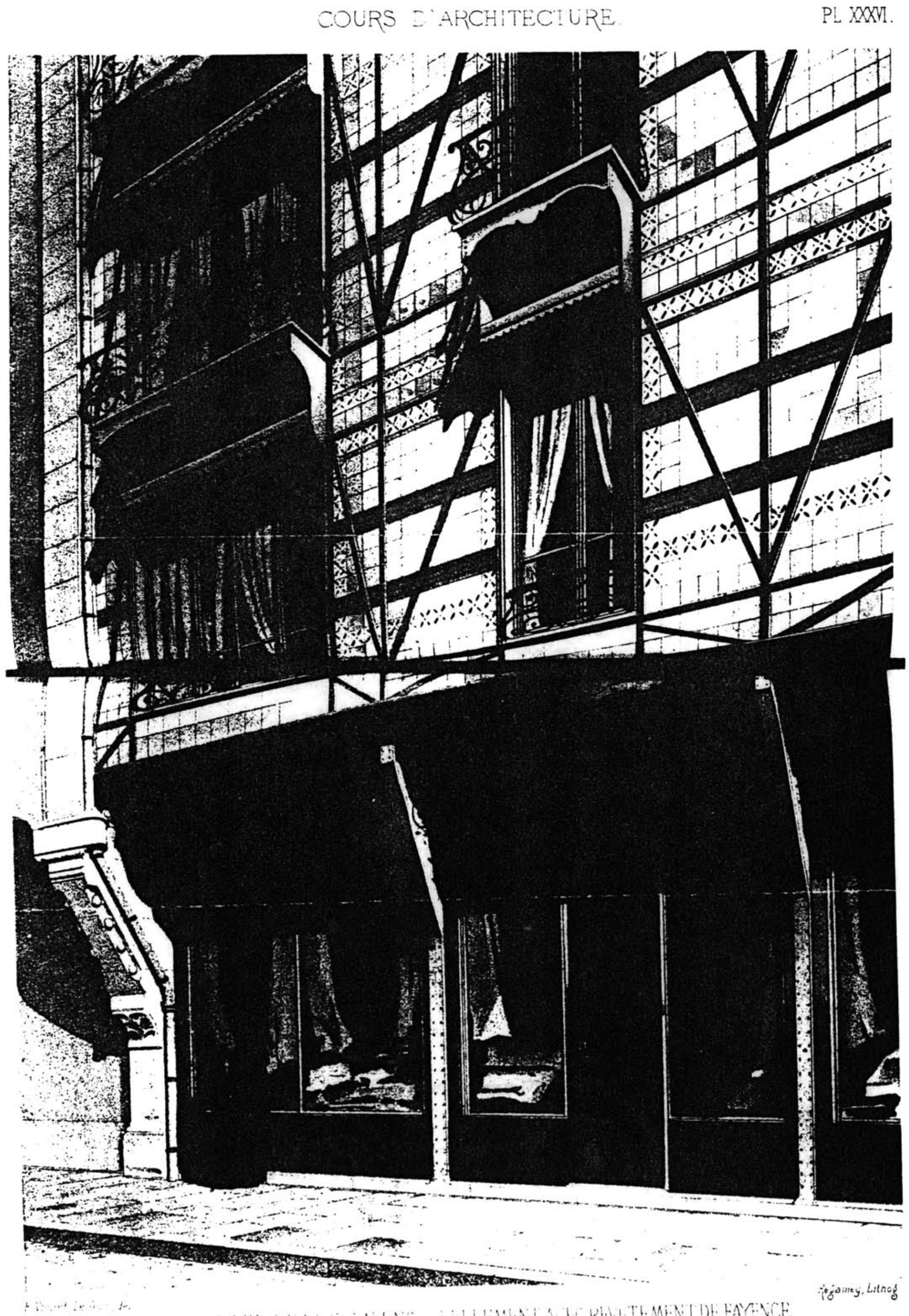
PALAIS DU CHAMP-DE-MARS.

VI.

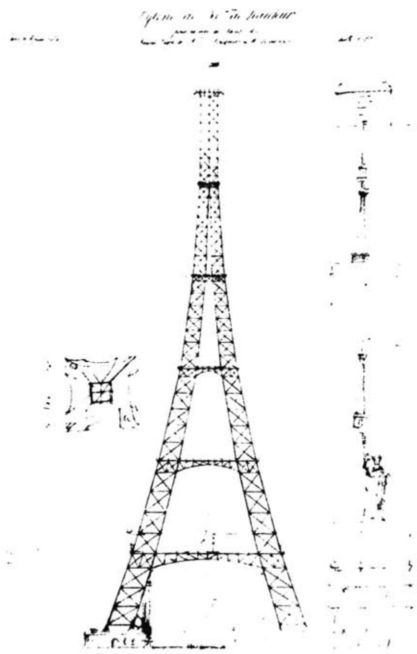
(fig. 122) Palais du Champs de Mars, 1878, detail, Encyclopédie 'architecture

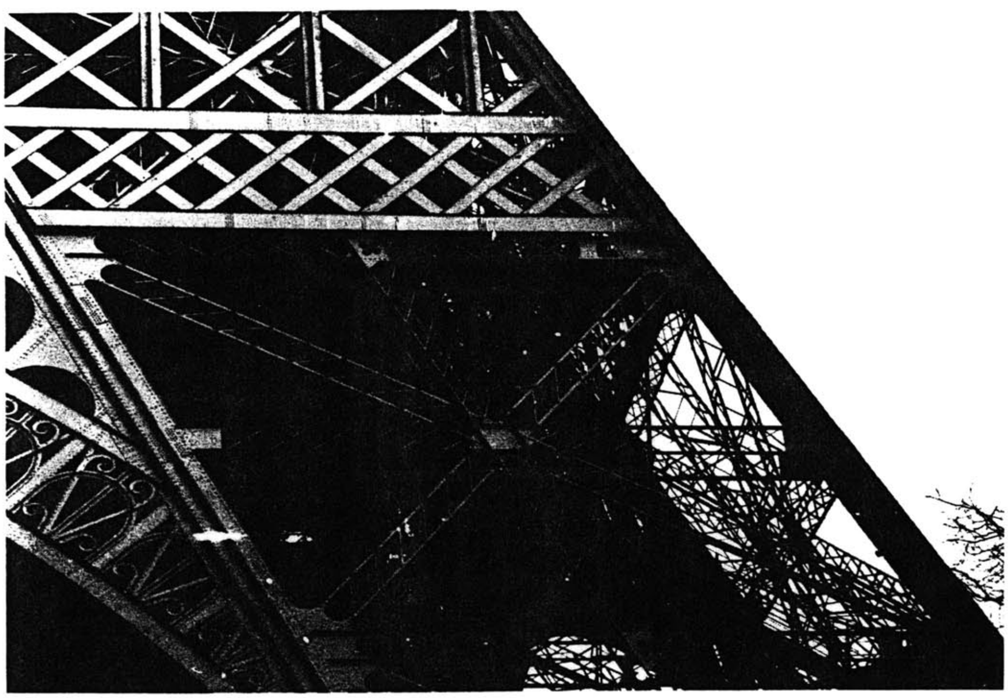


(fig. 123) Palais du Champs de Mars, 1878, corner pavilions

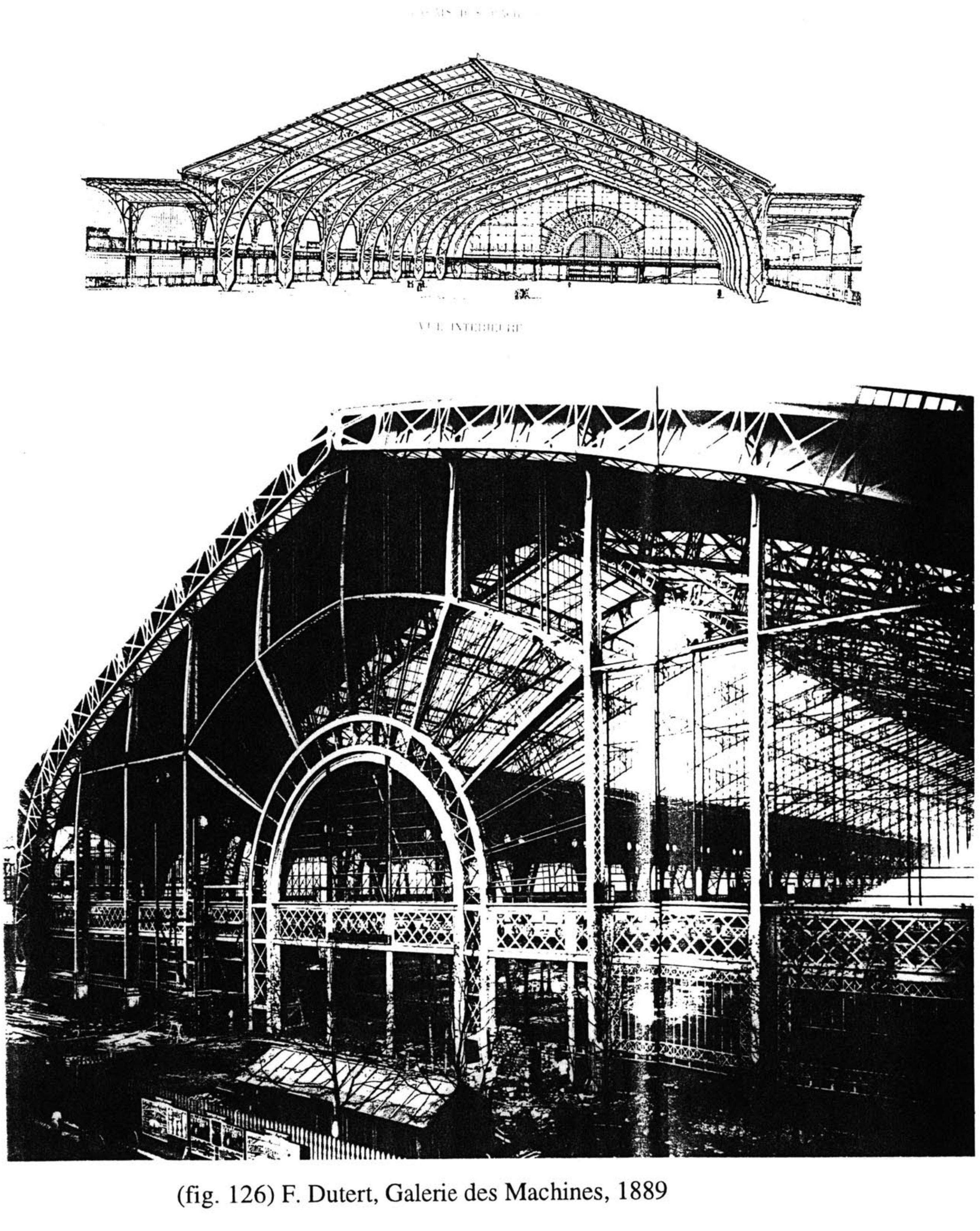


(fig. 124) Viollet-le-Duc, house of *pan de fer* , 1872, Entretiens

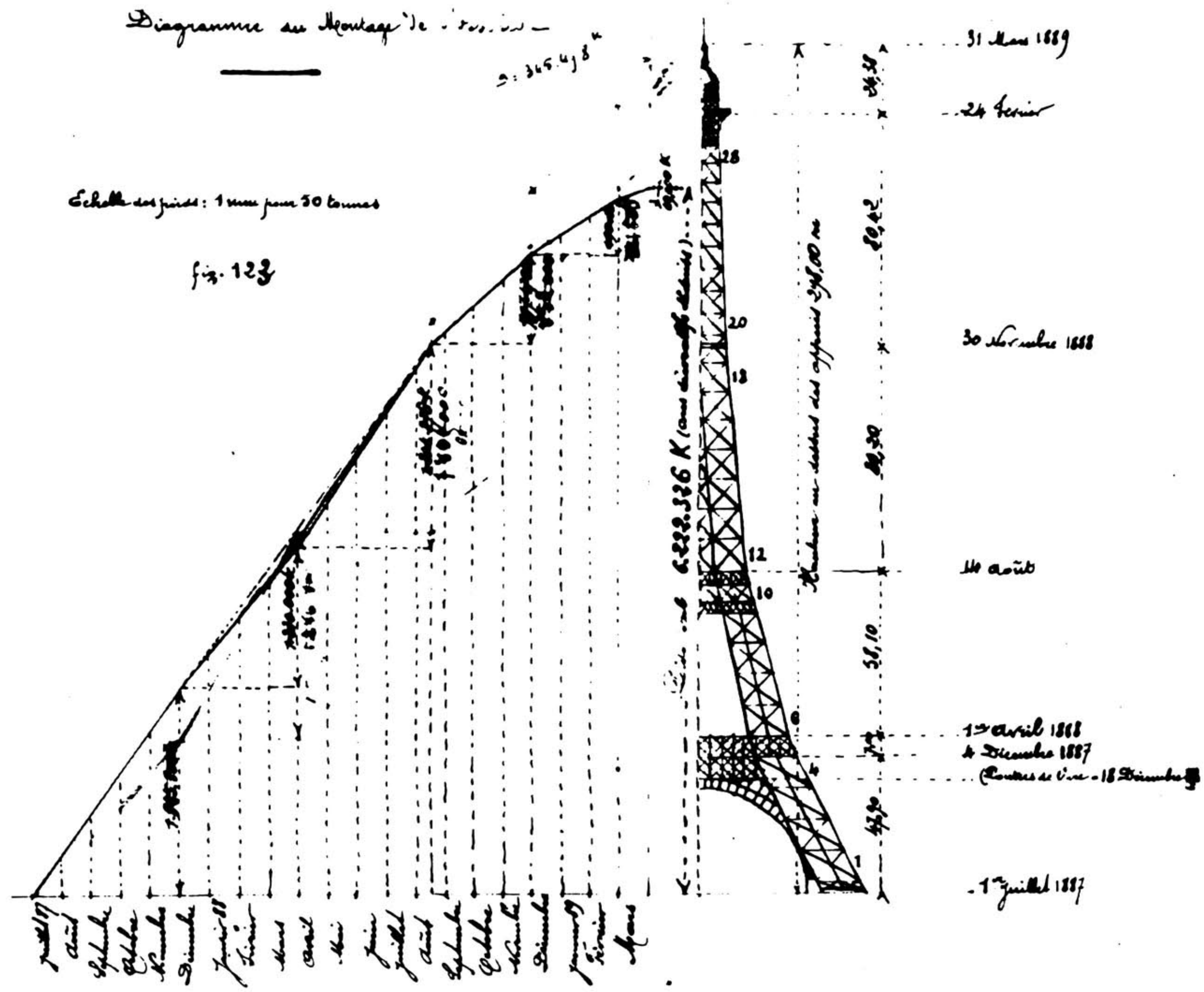




(fig. 125) G. Eiffel, Eiffel tower, 1889

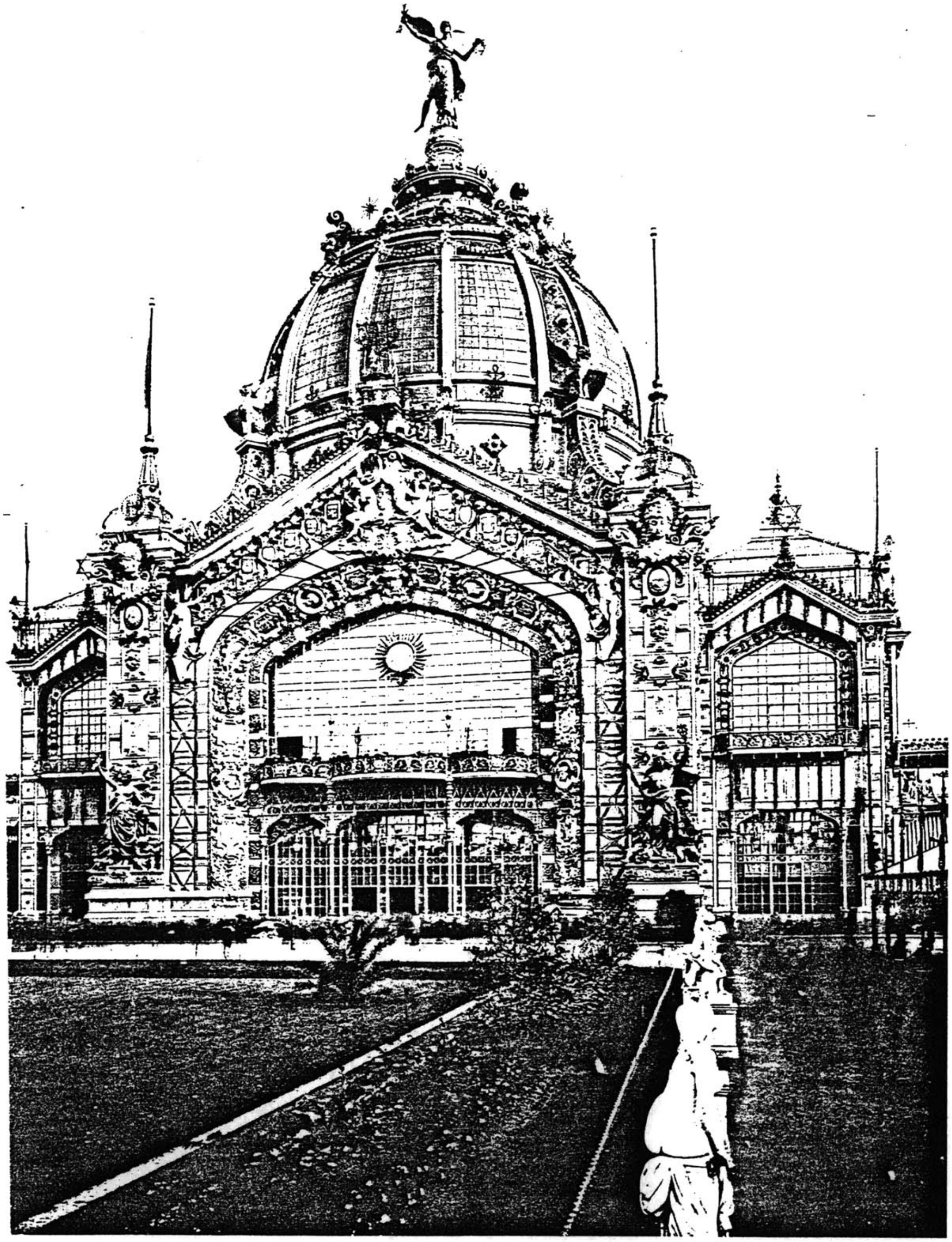


(fig. 126) F. Dutert, Galerie des Machines, 1889

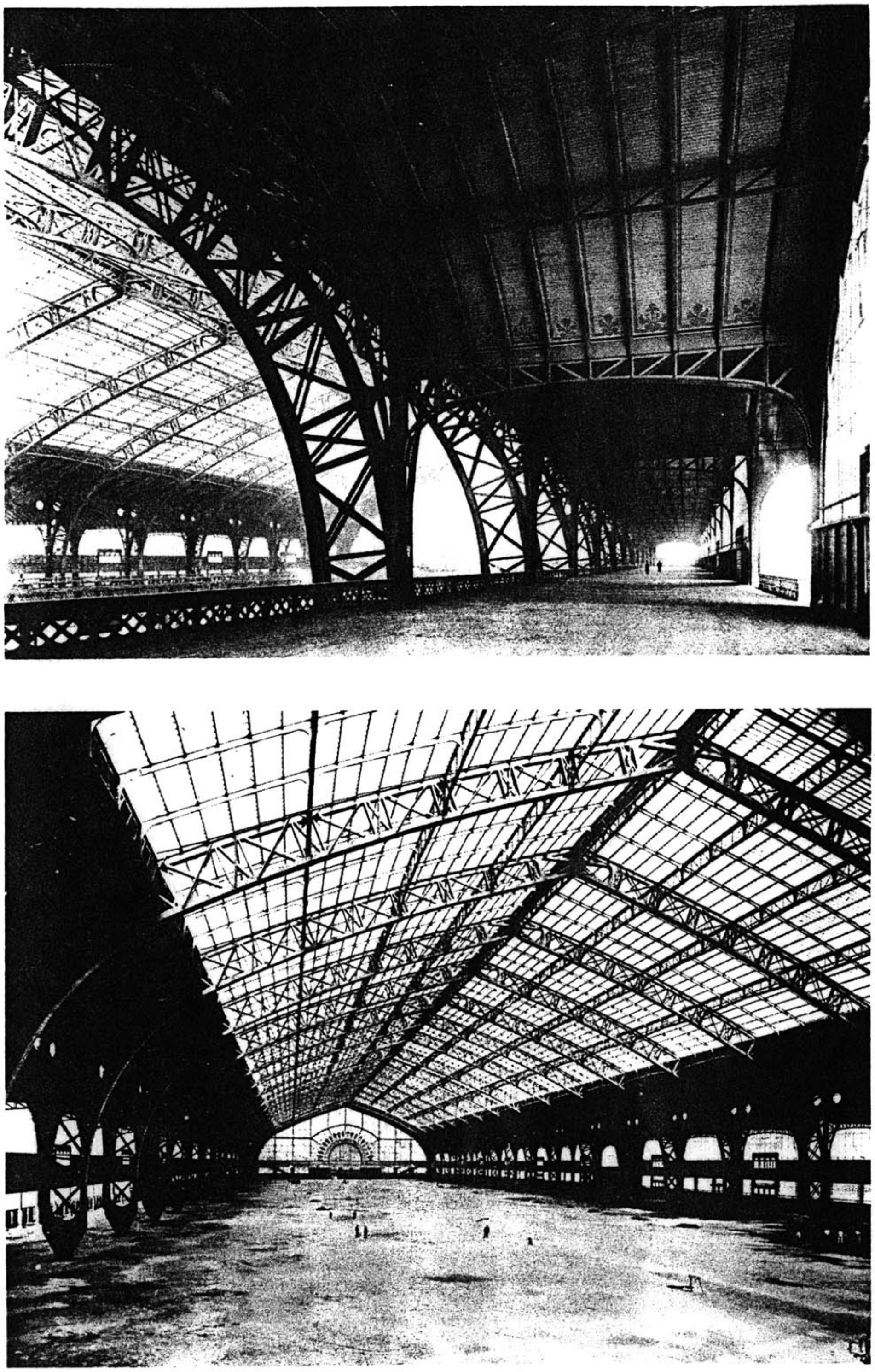


113 *Eiffel Tower*, diagram for the erection of the frame, tracing. Paris, Musée d'Orsay, Eiffel collection.

(fig. 127) G. Eiffel, diagram for the erection of the frame



(fig. 128) Jean Formigé, pavilion des Beaux-Arts, 1889



(fig. 129) Dutert, Galerie des Machines, 1889, interior view

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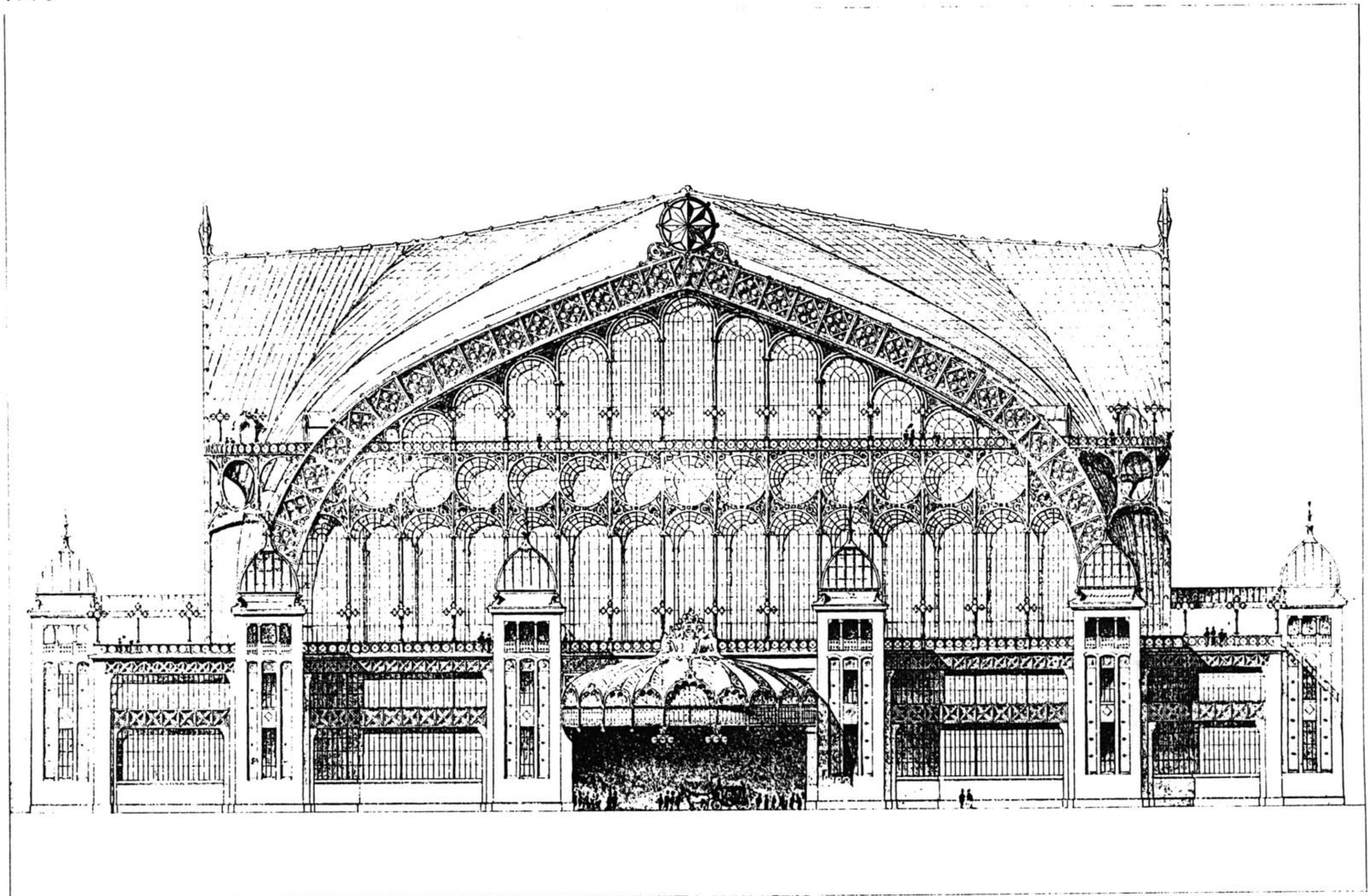
IV^E S^IE PL.125



A. DE BAUDOT, ARCH^TE Héliogravure Dujardin

PROJET DE GRANDE SALLE

(COURS DU TROCADERO)

ESSAI D'APPLICATION DE LA METHODE DE COMPOSITION

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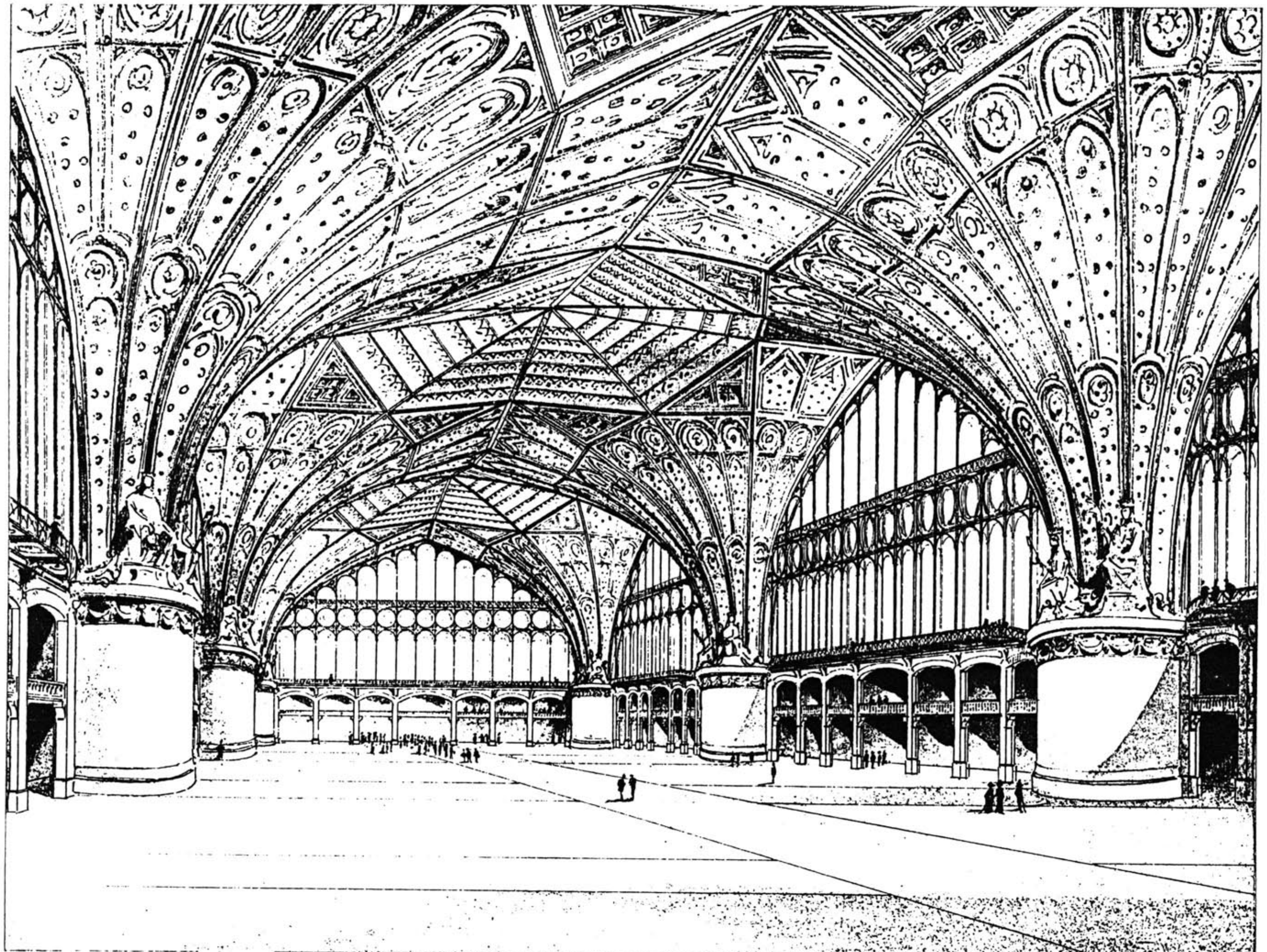
(fig. 130) Anatole de Baudot, project for Grand salle, 1889, elevation

ENCYCLOPEDIE D'ARCHITECTURE

IVE SIE PL. 126

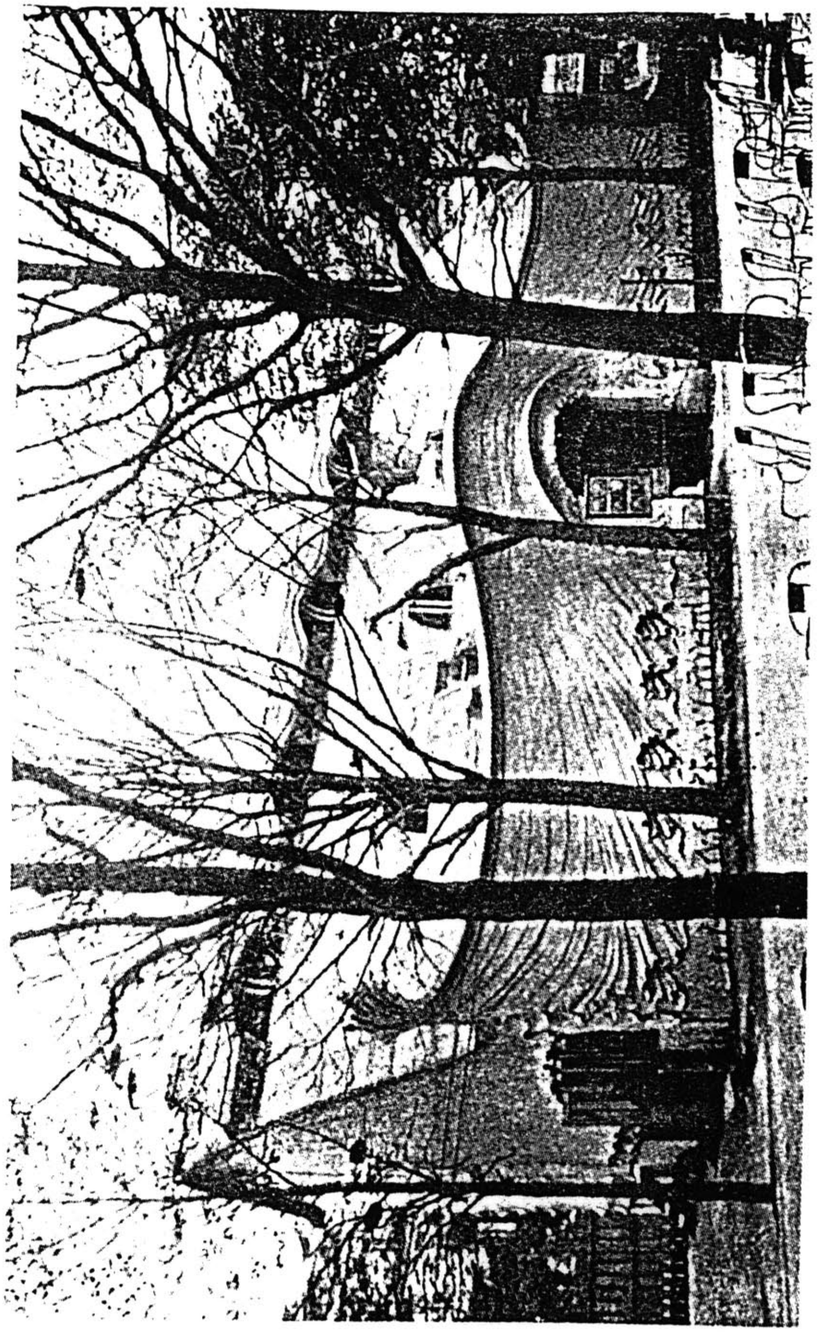


A. DE BAUDOT, ARCHTE Héliogravure Dujardin

PROJET DE GRANDE SALLE

(COURS DU TROCADERO)

(fig. 131) Anatole de Baudot, project for Grand salle, 1889, interior view



(fig. 132) Loië Fuller Theater, 1900

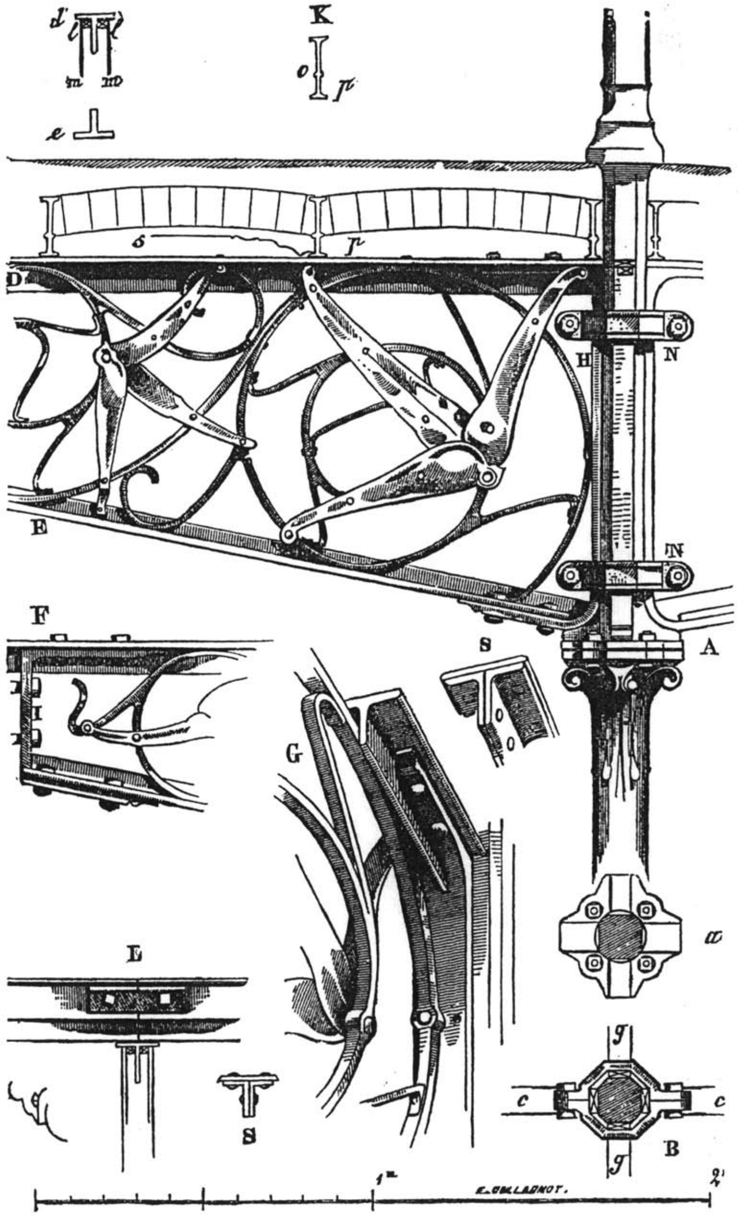
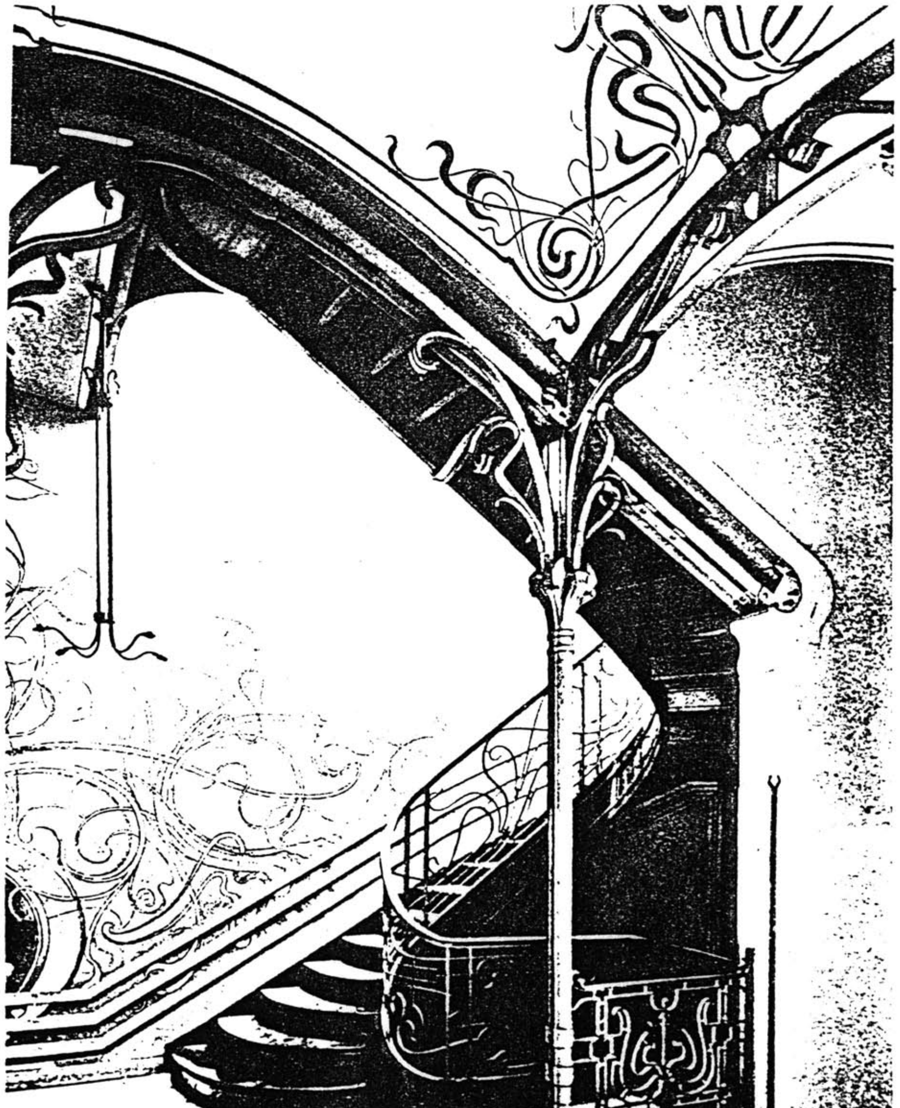
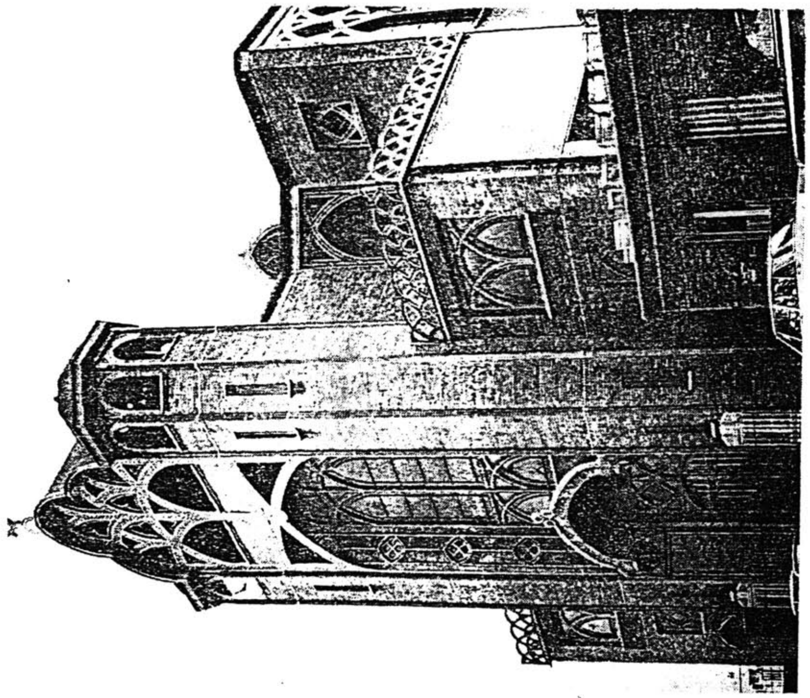


FIG. 1.—Details of the Great Floor.

(fig. 133) Viollet-le-Duc, details of great floor, Entretiens



(fig. 134) Victor Horta, Hotel Tassel, 1892



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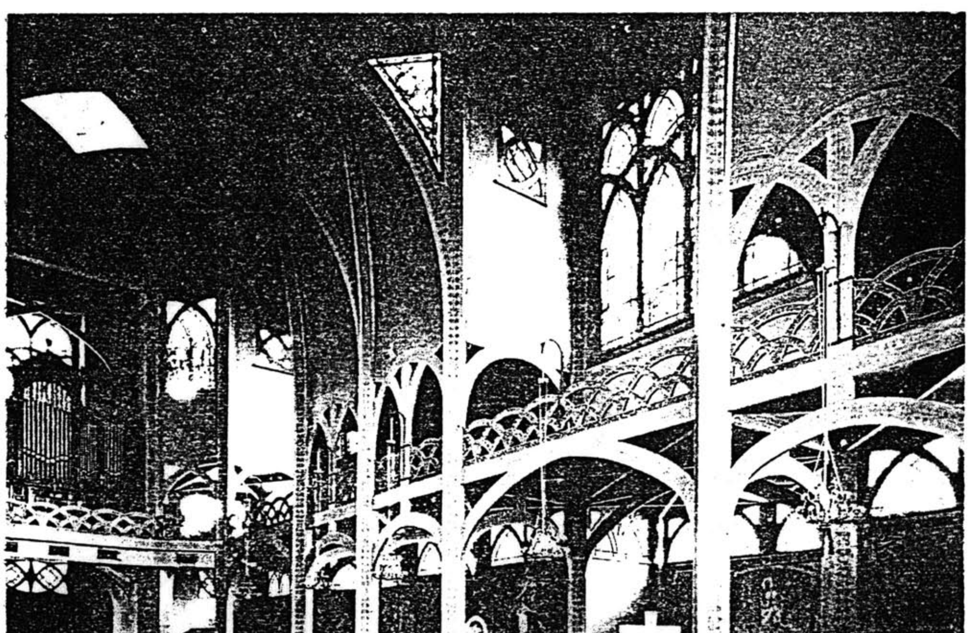

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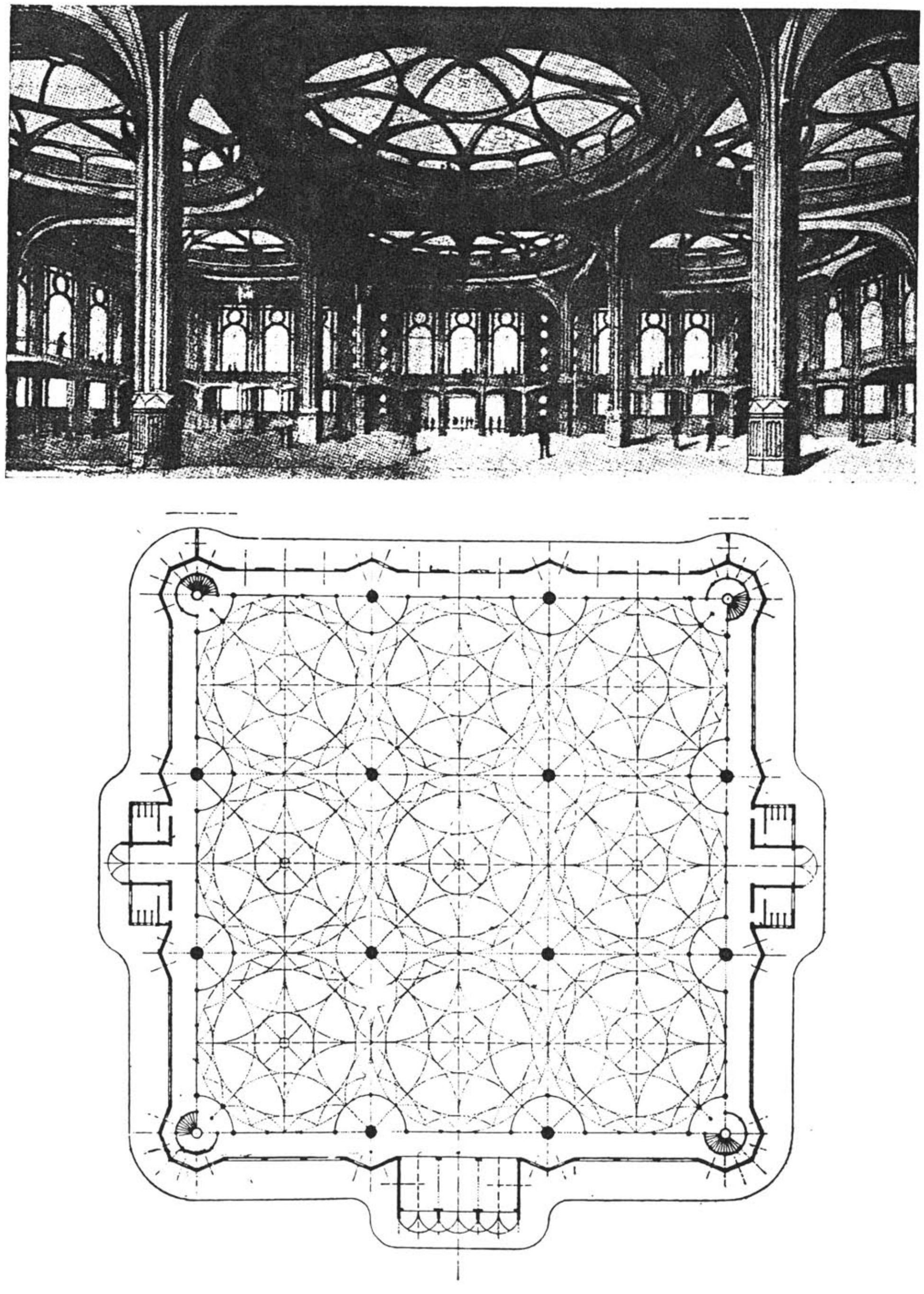
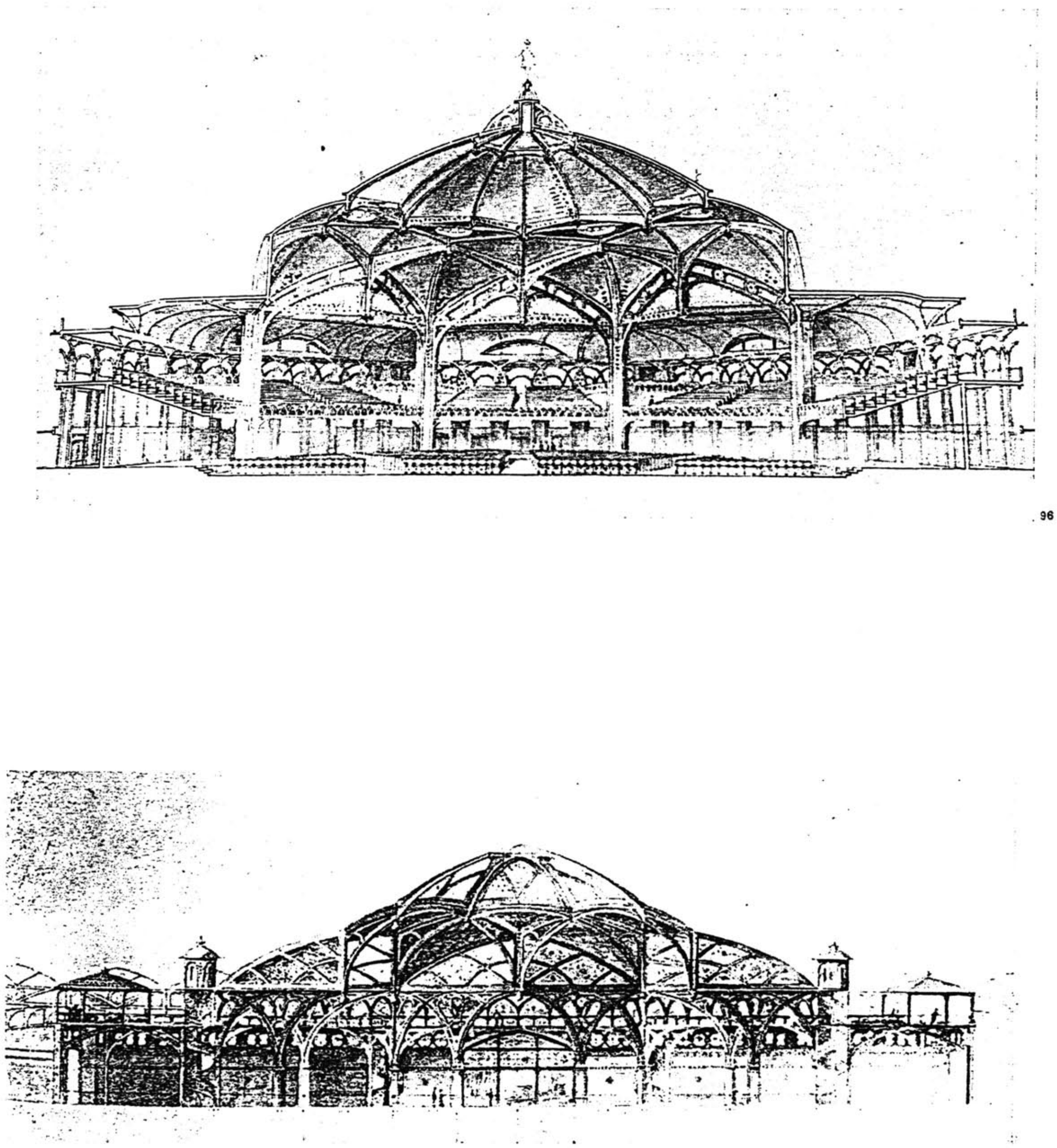
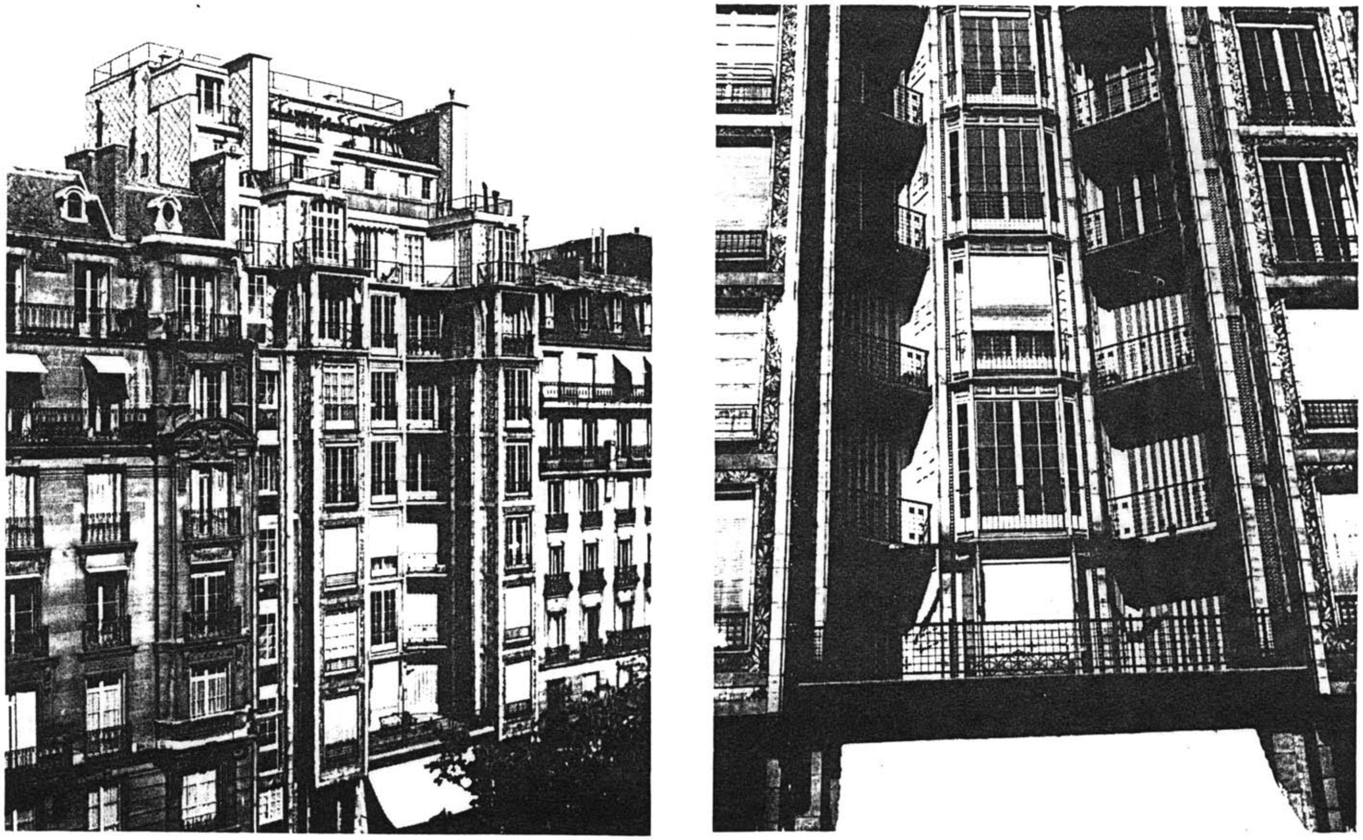
(fig. 135) Anatole de Baudot, reinforced concrete church of St.-Jean-de Montmartre, 1897



(fig. 136) Anatole de Baudot, project for reinforced concrete hall, c. 1910

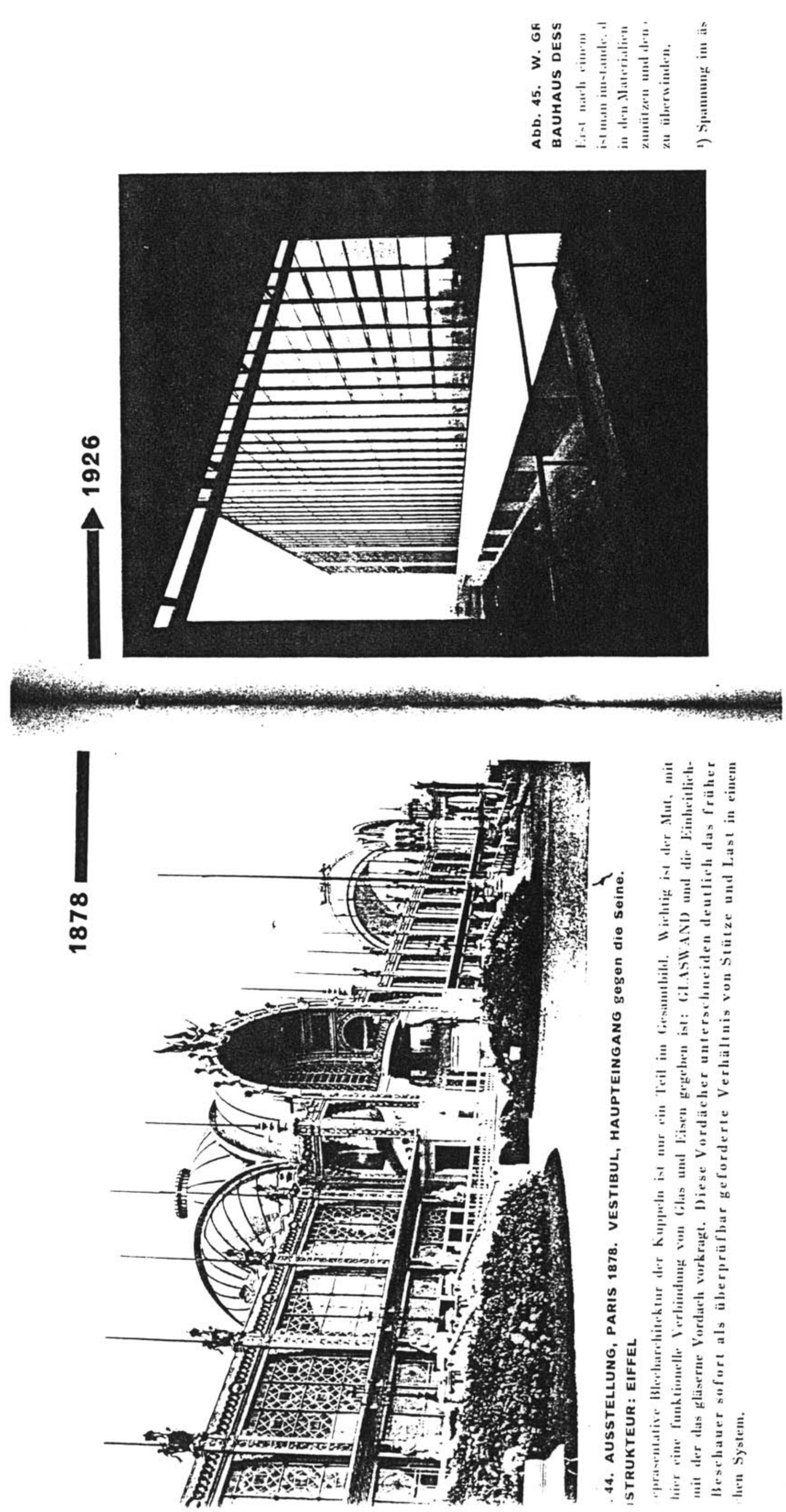


(fig. 137) Anatole de Baudot, project for reinforced concrete halls, 1911, 1913 (fig. 138) Auguste Perret, apartment, 25 bis, rue Frankline, 1903-4



AUGUSTE PERRET: EARLY REINFORCED CONCRETE FRAME STRUCTURES

50. Paris: 25b, Rue Franklin, 1903. General view, and detail of the façade



(fig. 139) S. Giedion, <u>Bauen in Frankreich, Bauen in Eisen, Bauen in Eisenbeton</u>, 1928, connection between the Palais du Champs de Mars(1878) and Bauhaus (1926)